

# Waikato River

WATER QUALITY MONITORING PROGRAMME

## Data Report 2003

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# 1 Introduction

## 1.1 Background

The year 2003 report follows the format of the previous data report (Smith, 2003), except that no information is reported for the microbiological bathing season as it was not conducted in the summer of 2003/2004.

To effectively manage water quality, the Waikato River monitoring programme addresses the following questions:

1. What is the quality of the water now?
2. Why is the water of the observed level of quality?
3. Is water quality getting better or worse? If so - what makes it change?
4. How can we improve the quality, ecological health and integrity of the Waikato River?

The monitoring information allows Environment Waikato to:

- Determine compliance with classification standards.
- Define the suitability of the resource for various beneficial uses and values of the water.
- Monitor the impact of major discrete point source discharges on water quality.
- Monitor the impacts of diffuse discharges on water quality.
- Provide a basis for evaluating the effectiveness of resource management measures.

This dataset is invaluable for the evaluation of the Waikato River: its state, the pressures on it and its response to these pressures. We need to continue to gather comprehensive, reliable and good quality data on the Waikato River to protect and enhance its values into the future.

This report is the 12<sup>th</sup> since the re-design of the Waikato River Monitoring Programme (WARIMP) implemented in 1989<sup>1</sup>. Copies of reports can be obtained via the Environment Waikato Internet site [www.ew.govt.nz](http://www.ew.govt.nz), or by contacting Environment Waikato (the Library) on 0800 800 401, e-mail: [inforeq@ew.govt.nz](mailto:inforeq@ew.govt.nz).

## 1.2 Report Content

The report provides information on:

1. Routine monthly monitoring of water quality at 10 sites:
  - Year 2003 summary data, tabulated by parameter for each location and reported with the median of the previous 5 years.
  - Key parameter graphs showing the average water quality for 2003 at each location, compared to results of the previous 5 years.
  - Summary tables identifying the number of samples meeting 'satisfactory' and 'excellent' water quality standards and guidelines.
  - Raw data for Year 2003.
2. Additional information is provided in the appendices on:
  - Flow (*Appendix I*).
    - The effect of flow is important to assessing water quality and making comparisons between years. Appendix I provides information on annual average flow at some locations for the previous 10 years.
  - Datasonde Deployments
    - Plots of deployments undertaken during 2003 showing the level of diurnal variation at five Waikato River sites (*Appendix II*).

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<sup>1</sup> Regional Rivers reported on separately – See Smith, 2004

## 1.3 Water Quality Guidelines and Standards

Table 1 lists the physical and chemical water quality standards and guidelines used to assess the condition of the Waikato River in 2003. The standards mainly relate to either the protection of the ecological health of rivers and streams or to whether they are suitable for water-based recreation, especially swimming.

Some water quality Guidelines and Standards are relevant to the use of the Waikato River for both general water supply (industrial/cooling water, irrigation, stock water etc.) and as a source of municipal drinking water. In most cases two criteria are shown. The less stringent criteria define water that is “satisfactory” for the desired use; these are mostly based on existing national and other Guidelines and Standards (Appendix IV). The more stringent criteria identify “excellent” water, and reflect expert opinion. Samples gathered in 2003 whose results do not comply with the “satisfactory” criteria (Table 1) are underlined in raw data summaries.

**Table 1: Guidelines and Standards for Physicochemical Water Quality for Ecological Health and for Human Uses of Water.**

Water Quality Measure	Relevance <sup>1</sup>	Satisfactory	Excellent
<b>Ecological Health</b>			
Dissolved oxygen (% saturation)	aquatic life (breathing)	>80	>90
pH	aquatic life (acidity)	6.5–9	7–8
Turbidity (NTU)	plant growth (clarity)	<5	<2
Ammoniacal-N (g/m <sup>3</sup> )	aquatic life (toxicity)	<0.88	<0.1
Temperature (°C) (May-Sep)	fish (spawning)	<12	<10
(Oct-Apr)		<20	<16
Total phosphorus (g/m <sup>3</sup> )	Nuisance plant growth	<0.04	<0.01
Total nitrogen (g/m <sup>3</sup> )	Nuisance plant growth	<0.5	<0.1
<b>Human Uses—recreation</b>			
Baseflow water clarity (m)	Visibility	>1.6	>4
Escherichia coli (no./100 mL)	human health	<550	<55
Median Escherichia coli (no./100 mL)	human health	<126	<23
Median enterococci (no./100 mL)	human health	<33	<6
<b>Human Uses—water supply</b>			
Phytoplankton chlorophyll a (g/m <sup>3</sup> )	filter blockage	<0.02	<0.005
<b>Human Uses—drinking water</b>			
Arsenic (g/m <sup>3</sup> )	human health (toxicity)	<0.01	–
Boron (g/m <sup>3</sup> )	human health (toxicity)	<1.4	–

<sup>1</sup> Refer to Appendix IV for description of Guideline and Standards values used. These guidelines and standards are also defined on the Environment Waikato Internet site; [www.ew.govt.nz](http://www.ew.govt.nz)

## 2 The Waikato River Monitoring Programme Design

### 2.1 Sampling Collection

Sample collection occurs monthly, as two sampling runs. Locations in the upper catchment from Taupo to Waipapa are visited as part of the first run, and locations in the middle and lower catchments from Hamilton (at the Narrows) to Tuakau are visited on the next. Each location is sampled at a similar time on each occasion (coefficient of variation ~2 - 6%) to minimise the effect of diurnal variation on the measurement of water quality parameters. Sample times are recorded in New Zealand Standard Time (NZST). Because of the controlled nature of the river, our daytime samples are generally collected at higher than median flows.

### 2.2 Sample Locations

Routine water quality monitoring locations of the Waikato River Monitoring Programme and additional locations used during the summer microbiological surveys are summarised in *Table 2* and illustrated in *Figure 1*.

**Table 2: Routine Sampling and Bathing Water Monitoring Locations.**

Location Number	Distance <sup>1</sup> (km)	Location Name	Map Ref.	Field <sup>r</sup> Measurements
1131.127	0.1	Taupo Gates	U18:772-757	–
1131.119* <sup>d</sup>	1.2	Taupo – Reids Farm	U18:778:763	true left bank
1131.70 <sup>b</sup>	6.0	Huka Falls	U18:789-792	–
1131.105 <sup>d</sup>	36.5	Ohaaki Bridge	U17:981-914	at bridge, true left bank
1131.107	75.8	Ohakuri Tailrace Bridge	U17:796-061	boat ramp <sup>2</sup>
1131.147	105.0	Whakamaru Tailrace	T17:552-056	boat ramp <sup>3</sup>
1131.143	126.1	Waipapa Tailrace	T16:448-200	boat ramp <sup>4</sup>
1131.81 <sup>b</sup>	166.7	Lake Karapiro Boat Ramp	T15:436-570	Horahora domain
1131.101	202.0	Hamilton – Narrows Bridge	S14:168-708	at jetty <sup>5</sup>
1131.145* <sup>b</sup>	210.8	Hamilton – Wellington St Bch	S14:117-757	at jetty, true right bank
1131.64 <sup>d</sup>	211.5	Hamilton – Traffic Bridge	S14:118-764	true right bank
1131.121 <sup>b</sup>	219.8	Hamilton – Sewer Bridge	S14:082-823	true left bank
1131.69	225.6	Horotiu Bridge	S14:048-871	d/s of bridge
1131.102 <sup>b</sup>	232.3	Ngaruawahia Bridge	S14:997-912	u/s of confluence <sup>6</sup>
1131.77	246.5	Huntly – Tainui Bridge	S13:003-018	boat ramp <sup>7</sup>
1131.117* <sup>d</sup>	262.3	Rangiriri Bridge	S13:989-167	true right bank
1131.91	286.3	Mercer Bridge	S12:919-336	–
1131.133	296.8	Tuakau Bridge	R12:828-320	boat ramp <sup>8</sup>
1131.131 <sup>d</sup>	306.5	Tuakau – Elbows Landing	R12:745-352	pumping station

<sup>1</sup> approximate distance (in kilometres) from Lake Taupo's outlet.

<sup>2</sup> boat ramp in recreation reserve immediately upstream from dam (true left bank).

<sup>3</sup> boat ramp at Whakamaru Power Station.

<sup>4</sup> river access d/s of Lake Waipapa, about 500 m off S.H. 32 along a gravel road (true left bank).

<sup>5</sup> jetty at Hamilton Gardens.

<sup>6</sup> road bridge upstream of Waipa River confluence.

<sup>7</sup> upstream of bridge, about 500 m off River Road (true left bank).

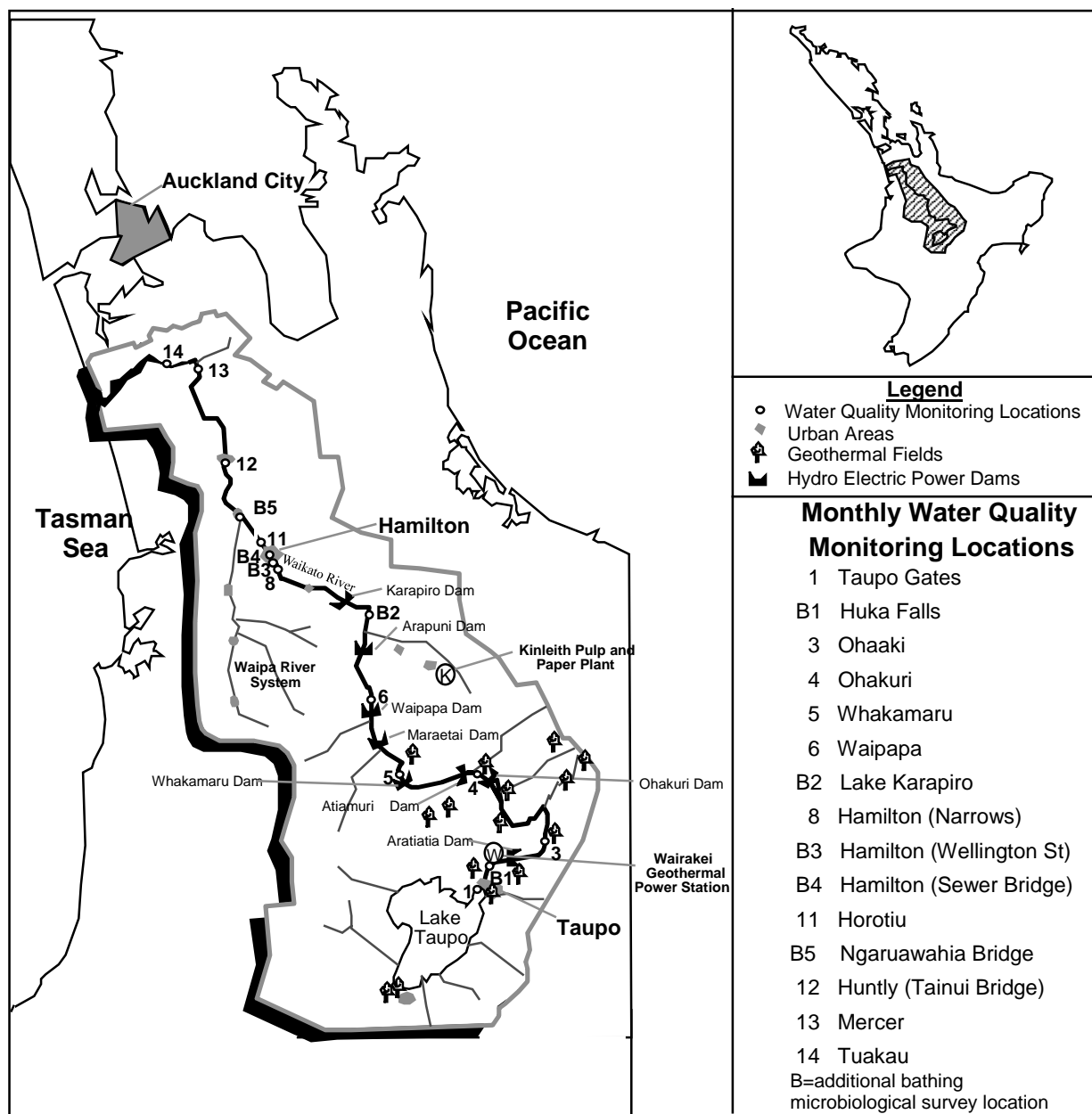
<sup>8</sup> immediately d/s of bridge, at Reserve (true right bank).

<sup>b</sup> bathing season intensive microbiological survey locations only – survey conducted over the 2002/2003 summer.

\* Locations at **Taupo (Reids Farm)**, 1.1 km d/s from Taupo Gates), at **Hamilton** (Wellington Street jetty) and at **Rangiriri** (Rangiriri Bridge) are sampled and reported as part of the National River Water Quality Network undertaken by NIWA. Contact person: Graham Bryers, NIWA, Hamilton.

<sup>r</sup> Logistic considerations mean field measurements are often made at slightly different locations from sample collection (e.g. sampling from bridges).

<sup>d</sup> Datasonde deployment sites, March and November.



**Figure 1: Waikato River Water Quality Monitoring Locations**

Ten locations along the river are visited monthly (Taupo, Ohaaki, Ohakuri, Whakamaru, Waipapa, Hamilton-Narrows, Hamilton-Horotiu, Huntly, Mercer and Tuakau), and an additional four locations are included for the summer intensive microbiological survey (see Table 2, Figure 1). The major tributaries that enter the Waikato River are also monitored monthly as part of the Regional River Monitoring Programme (RERIMP) initiated in 1993 (Huser and Wilson, 1996b). Three locations (Taupo at Reids Farm, Hamilton at Wellington Street, and Rangiriri) are sampled by NIWA as part of the 'National River Water Quality Network' (Table 2).

## 2.3 Water Quality Parameters

Water quality of the Waikato River is assessed by measuring up to 40 parameters (27 routinely). Some parameters are measured in the field, but the majority of parameters are analysed in a laboratory using standard analytical methods. Details of field measurements and analytical methods used are appended (Appendix III).

## 2.4 Quality Control, Data Storage and Analysis

Quality control measures are undertaken in accordance with Environment Waikato's ISO 9001:2000 standards including procedures for the collection, transport, storage, of samples, and methods for data verification and quality assurance to ensure the

consistency of data across the programme. Samples are sent to IANZ registered laboratories for analysis. Back-up samples are held for two months until results have been verified by routine quality assurance procedures. All data from field measurements and laboratory analyses are stored in Environment Waikato's water quality archiving database (HYDROL).

Data analysis was performed using Statistica (version 6.0) and DataDesk (version 6.0.1). For the purpose of data analysis, non-detect results (i.e. results with "less than" values) were assumed to be equal to half the corresponding limit of detection (i.e.  $<x = x/2$ ), and results greater than the value reported were taken as equal to the value reported (i.e.  $>x = x$ ).

## 2.5 Reports

Environment Waikato's State of the Environment Report summarises the state of the Waikato River, other rivers in the region, and common pressures (Environment Waikato, 1999)

Environment Waikato Technical Report 2004/02 Trends in river water quality in the Waikato Region, 1987-2002 (Vant & Smith, 2004) outlines the trends in the Waikato River and other rivers in the region (see Appendix III).

The data contained in these Waikato River reports is updated to the Environment Waikato "Waikato River" Internet page:

[www.ew.govt.nz/ourenvironment/water/healthyivers/waikato/index.htm](http://www.ew.govt.nz/ourenvironment/water/healthyivers/waikato/index.htm)

Upon completion of the report. The "Healthy Rivers" page provides a link to details of the Guidelines and Standards used to assess the condition of the Waikato River and other rivers in the region. A link to water quality at other Regional River monitoring sites is also available from this page.

## 3 Results

The results are presented in Section 3.1, containing the results and statistical summaries of the routine monitoring of the Waikato River. The raw data is included.



## **3.1 Waikato River Monitoring Programme Routine Water Quality Monitoring**

**Summary Statistics**

**Key Parameter Graphs**

**Comparison with Water Quality Standards**

**Raw Data**

Absorbance of filtered sample at 340 nm (units: cm <sup>-1</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.003	0.002	0.001	0.008	0.004	1.16	0.001
Ohaaki Bridge	12	0.004	0.003	0.001	0.012	0.004	1.17	0.003
Ohakuri Tailrace Bridge	12	0.008	0.007	0.002	0.015	0.005	0.44	0.005
Whakamaru Tailrace	12	0.007	0.006	0.003	0.016	0.005	1.12	0.006
Waipapa Tailrace	12	0.010	0.011	0.005	0.016	0.005	0.03	0.009
Narrows Bridge	12	0.012	0.013	0.007	0.016	0.004	-0.36	0.012
Horotiu Bridge	12	0.014	0.014	0.009	0.018	0.005	-0.17	0.012
Huntly-Tainui Bridge	12	0.019	0.019	0.013	0.027	0.007	0.31	0.017
Mercer Bridge	12	0.024	0.024	0.017	0.038	0.007	0.89	0.022
Tuakau Bridge	12	0.027	0.025	0.018	0.044	0.010	0.93	0.024

Absorbance of filtered sample at 440 nm (units: cm <sup>-1</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.001	0.001	0.001	0.001	0.000	-1.00	0.001
Ohaaki Bridge	12	0.001	0.001	0.001	0.003	0.001	1.68	0.001
Ohakuri Tailrace Bridge	12	0.002	0.001	0.001	0.004	0.001	<u>1.71</u>	0.001
Whakamaru Tailrace	12	0.001	0.001	0.001	0.003	0.000	<u>2.22</u>	0.001
Waipapa Tailrace	12	0.002	0.002	0.001	0.004	0.002	0.86	0.002
Narrows Bridge	12	0.002	0.002	0.001	0.005	0.002	0.86	0.002
Horotiu Bridge	12	0.003	0.002	0.001	0.007	0.002	1.34	0.002
Huntly-Tainui Bridge	12	0.004	0.003	0.002	0.007	0.003	0.96	0.003
Mercer Bridge	12	0.005	0.004	0.002	0.011	0.003	1.20	0.004
Tuakau Bridge	12	0.005	0.005	0.002	0.010	0.002	0.88	0.004

Arsenic - Total (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.010	0.010	0.010	0.011	0.001	0.71	0.010
Ohaaki Bridge	12	0.036	0.032	0.025	0.066	0.009	1.49	0.025
Ohakuri Tailrace Bridge	12	0.036	0.036	0.027	0.046	0.010	0.22	0.029
Whakamaru Tailrace	12	0.034	0.034	0.024	0.047	0.004	0.63	0.029
Waipapa Tailrace	12	0.029	0.030	0.023	0.039	0.007	0.44	0.025
Narrows Bridge	12	0.027	0.028	0.020	0.032	0.006	-0.65	0.023
Horotiu Bridge	12	0.026	0.027	0.020	0.032	0.005	-0.48	0.022
Huntly-Tainui Bridge	12	0.019	0.019	0.009	0.027	0.008	-0.18	0.018
Mercer Bridge	12	0.019	0.020	0.011	0.027	0.008	-0.01	0.016
Tuakau Bridge	12	0.019	0.019	0.010	0.027	0.009	0.12	0.015

Boron (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.16	0.16	0.15	0.17	0.01	-0.63	0.16
Ohaaki Bridge	12	0.36	0.32	0.26	0.59	0.14	1.06	0.27
Ohakuri Tailrace Bridge	12	0.35	0.35	0.30	0.44	0.05	0.90	0.30
Whakamaru Tailrace	12	0.33	0.33	0.28	0.40	0.05	0.52	0.29
Waipapa Tailrace	12	0.29	0.29	0.24	0.34	0.05	-0.11	0.26
Narrows Bridge	12	0.27	0.26	0.24	0.34	0.05	0.68	0.24
Horotiu Bridge	12	0.27	0.27	0.23	0.32	0.06	0.42	0.24
Huntly-Tainui Bridge	12	0.21	0.21	0.11	0.29	0.08	-0.12	0.19
Mercer Bridge	12	0.22	0.21	0.14	0.29	0.07	0.13	0.18
Tuakau Bridge	12	0.21	0.20	0.12	0.30	0.06	0.09	0.18

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Black Disk (m)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	-	-	-	-	-	-	-	-
Ohaaki Bridge	12	5.2	5.4	3.4	6.6	1.5	-0.33	5.9
Ohakuri Tailrace Bridge	12	2.7	2.6	1.6	5.0	0.5	<u>1.83</u>	3.0
Whakamaru Tailrace	12	2.2	2.1	1.2	3.8	0.7	0.83	2.5
Waipapa Tailrace	12	2.0	2.0	1.3	2.8	0.6	0.21	2.5
Narrows Bridge	12	1.4	1.3	0.9	2.3	0.7	0.76	1.4
Horotiu Bridge	12	1.3	1.2	0.8	2.0	0.6	0.60	1.4
Huntly-Tainui Bridge	12	0.9	0.9	0.5	1.6	0.4	0.59	0.9
Mercer Bridge	-	-	-	-	-	-	-	-
Tuakau Bridge	12	0.7	0.6	0.4	1.2	0.3	0.78	0.6

Biochemical Oxygen Demand - 5 day (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.5	0.4	0.2	1.7	0.4	<u>2.03</u>	0.2
Ohaaki Bridge	12	0.5	0.5	0.2	0.9	0.4	0.53	0.5
Ohakuri Tailrace Bridge	12	0.6	0.7	0.2	1.4	0.5	0.50	0.5
Whakamaru Tailrace	12	0.7	0.8	0.2	1.2	0.4	-0.23	0.7
Waipapa Tailrace	12	0.7	0.8	0.2	1.3	0.7	-0.24	0.7
Narrows Bridge	12	0.8	0.8	0.2	1.3	0.4	-0.09	0.7
Horotiu Bridge	12	1.0	0.9	0.4	1.7	0.7	0.19	0.9
Huntly-Tainui Bridge	12	0.9	0.9	0.4	1.3	0.4	-0.36	1.0
Mercer Bridge	12	1.3	1.3	0.6	2.5	0.6	1.06	1.1
Tuakau Bridge	12	1.3	1.4	0.2	2.3	0.6	-0.11	1.2

Carbon - Dissolved Organic (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.67	0.65	0.40	1.00	0.35	0.34	0.80
Ohaaki Bridge	12	0.60	0.60	0.20	1.00	0.35	0.17	0.70
Ohakuri Tailrace Bridge	12	0.68	0.60	0.30	1.10	0.30	0.46	0.80
Whakamaru Tailrace	12	0.67	0.55	0.20	1.20	0.50	0.42	0.95
Waipapa Tailrace	12	0.74	0.70	0.20	1.20	0.55	0.00	1.05
Narrows Bridge	12	0.89	0.75	0.40	1.50	0.65	0.30	1.15
Horotiu Bridge	12	1.10	0.80	0.40	3.80	0.60	<u>2.14</u>	1.20
Huntly-Tainui Bridge	12	1.14	0.90	0.60	2.20	0.60	0.90	1.40
Mercer Bridge	12	1.56	1.15	0.80	4.20	1.05	<u>1.70</u>	1.50
Tuakau Bridge	12	1.54	1.25	0.70	3.50	0.80	1.28	1.70

Carbon - Total Organic (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	1.05	1.00	0.80	1.40	0.25	0.59	1.00
Ohaaki Bridge	12	1.06	1.00	0.80	1.70	0.25	1.44	1.00
Ohakuri Tailrace Bridge	12	1.18	1.10	0.90	1.80	0.20	1.22	1.15
Whakamaru Tailrace	12	1.29	1.25	0.90	2.20	0.40	1.46	1.20
Waipapa Tailrace	12	1.49	1.50	1.00	2.10	0.50	0.13	1.40
Narrows Bridge	12	1.75	1.80	1.10	2.50	0.70	0.09	1.60
Horotiu Bridge	12	2.02	1.90	1.20	4.20	1.00	1.53	1.70
Huntly-Tainui Bridge	12	2.29	2.20	1.50	4.00	0.85	1.13	2.05
Mercer Bridge	12	3.12	2.75	1.90	5.00	1.65	0.69	2.55
Tuakau Bridge	12	3.28	3.40	1.80	5.50	1.35	0.56	2.90

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Chloride ( $\text{g m}^{-3}$ )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	9	9	8	10	1	-0.19	9
Ohaaki Bridge	12	25	22	16	55	6	<u>2.00</u>	17
Ohakuri Tailrace Bridge	12	24	25	19	28	5	-0.42	21
Whakamaru Tailrace	12	23	23	18	30	4	0.34	20
Waipapa Tailrace	12	21	21	17	26	2	0.16	19
Narrows Bridge	12	21	21	18	25	3	0.37	18
Horotiu Bridge	12	21	21	19	25	4	0.34	18
Huntly-Tainui Bridge	12	19	19	16	24	5	0.25	17
Mercer Bridge	12	20	20	17	24	3	0.39	17
Tuakau Bridge	12	20	20	17	24	4	0.16	17

Chlorophyll a ( $\text{g m}^{-3}$ )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.002	0.002	0.002	0.002	0.000	1.00	0.002
Ohaaki Bridge	12	0.002	0.002	0.002	0.003	0.000	<u>1.79</u>	0.002
Ohakuri Tailrace Bridge	12	0.006	0.005	0.002	0.013	0.005	0.74	0.005
Whakamaru Tailrace	12	0.009	0.009	0.002	0.018	0.008	0.32	0.008
Waipapa Tailrace	12	0.009	0.009	0.002	0.021	0.008	0.52	0.008
Narrows Bridge	12	0.015	0.014	0.003	0.029	0.012	0.20	0.012
Horotiu Bridge	12	0.019	0.016	0.005	0.036	0.016	0.24	0.013
Huntly-Tainui Bridge	12	0.015	0.014	0.002	0.033	0.015	0.45	0.015
Mercer Bridge	12	0.022	0.019	0.003	0.047	0.014	0.61	0.019
Tuakau Bridge	12	0.029	0.026	0.006	0.064	0.027	0.57	0.022

Colour (Munsell Colour Units)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	-	-	-	-	-	-	-	-
Ohaaki Bridge	12	49.0	47.5	45.0	57.5	7.5	0.74	50.0
Ohakuri Tailrace Bridge	12	38.8	38.8	35.0	42.5	2.5	0.00	40.0
Whakamaru Tailrace	12	37.3	37.5	32.5	40.0	5.0	-0.41	37.5
Waipapa Tailrace	12	35.2	35.0	30.0	37.5	2.5	-0.94	35.0
Narrows Bridge	12	34.4	35.0	30.0	37.5	3.8	-0.45	35.0
Horotiu Bridge	12	33.1	32.5	30.0	35.0	2.5	-0.15	32.5
Huntly-Tainui Bridge	12	31.7	30.0	27.5	37.5	3.8	0.69	32.5
Mercer Bridge	-	-	-	-	-	-	-	-
Tuakau Bridge	12	29.4	30.0	27.5	35.0	2.5	1.37	30.0

Conductivity at 25 °C ( $\text{ms m}^{-1}$ )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	12.2	12.2	11.6	13.1	0.6	0.47	12.0
Ohaaki Bridge	12	17.8	16.9	14.5	30.0	3.5	<u>2.09</u>	15.2
Ohakuri Tailrace Bridge	12	17.9	17.8	16.2	21.0	2.4	0.69	16.5
Whakamaru Tailrace	12	17.5	17.2	15.6	19.8	2.7	0.23	16.3
Waipapa Tailrace	12	16.5	16.6	15.0	17.5	1.5	-0.38	15.8
Narrows Bridge	12	16.4	16.4	14.5	17.9	1.3	-0.23	15.4
Horotiu Bridge	12	16.1	16.3	13.3	17.8	1.1	-0.87	15.6
Huntly-Tainui Bridge	12	15.3	15.9	13.5	17.1	2.5	-0.19	14.8
Mercer Bridge	12	15.9	16.0	14.6	17.4	1.9	0.12	15.2
Tuakau Bridge	12	15.8	16.0	14.4	17.2	1.9	-0.03	15.1

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Dissolved Oxygen (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	9.9	10.0	9.3	10.7	0.8	0.28	10.0
Ohaaki Bridge	12	9.6	9.6	7.5	11.0	2.0	-0.22	9.9
Ohakuri Tailrace Bridge	12	9.7	9.7	8.2	11.1	1.5	-0.24	9.8
Whakamaru Tailrace	12	10.1	9.9	9.4	11.6	1.4	0.76	9.9
Waipapa Tailrace	12	9.9	9.8	8.9	11.3	0.8	0.42	9.9
Narrows Bridge	12	9.8	9.9	8.1	11.4	1.0	-0.25	10.0
Horotiu Bridge	12	10.0	10.1	8.7	11.2	0.5	-0.04	10.0
Huntly-Tainui Bridge	12	9.6	9.7	7.9	11.2	0.9	0.01	9.8
Mercer Bridge	12	9.7	9.7	8.6	11.1	0.6	0.54	9.8
Tuakau Bridge	12	9.9	10.1	8.7	10.7	1.3	-0.32	9.8

Dissolved Oxygen (% Saturation)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	102.1	102.9	97.2	106.1	5.5	-0.23	100.8
Ohaaki Bridge	12	101.0	99.6	90.1	112.1	6.1	0.34	104.1
Ohakuri Tailrace Bridge	12	103.0	104.6	88.6	114.2	16.1	-0.20	101.3
Whakamaru Tailrace	12	106.1	106.9	97.2	114.5	9.9	-0.21	105.5
Waipapa Tailrace	12	101.7	100.6	96.2	107.3	5.6	0.24	103.0
Narrows Bridge	12	100.0	99.6	90.8	106.5	6.7	-0.28	100.6
Horotiu Bridge	12	102.0	99.9	94.4	112.6	8.2	0.49	100.0
Huntly-Tainui Bridge	12	97.5	99.0	86.5	105.0	9.2	-0.44	98.5
Mercer Bridge	12	100.3	100.0	82.8	111.2	13.2	-0.43	99.6
Tuakau Bridge	12	103.8	99.3	84.6	123.7	22.5	0.18	100.5

Enterococci (n/100 mL)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	2	2	1	7	2	1.36	2
Ohaaki Bridge	12	15	10	3	38	20	0.73	8
Ohakuri Tailrace Bridge	12	3	1	1	8	3	1.22	2
Whakamaru Tailrace	12	8	4	1	33	8	1.58	2
Waipapa Tailrace	12	11	5	1	50	10	1.64	3
Narrows Bridge	12	29	20	2	109	21	<u>1.91</u>	24
Horotiu Bridge	12	45	24	6	198	43	<u>2.24</u>	43
Huntly-Tainui Bridge	12	47	25	8	250	19	<u>2.61</u>	36
Mercer Bridge	12	43	12	4	350	14	<u>2.96</u>	16
Tuakau Bridge	12	44	15	4	340	17	<u>2.94</u>	17

Escherichia coli (n/100 mL)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	1	1	1	5	0	<u>2.74</u>	1
Ohaaki Bridge	12	30	12	5	150	16	<u>2.21</u>	16
Ohakuri Tailrace Bridge	12	5	3	1	19	3	<u>1.76</u>	2
Whakamaru Tailrace	12	12	8	2	43	11	1.53	4
Waipapa Tailrace	12	16	12	1	50	12	1.36	13
Narrows Bridge	12	82	30	12	460	35	<u>2.15</u>	48
Horotiu Bridge	12	87	75	13	220	95	0.80	90
Huntly-Tainui Bridge	12	251	195	21	900	218	1.47	170
Mercer Bridge	12	208	80	26	1300	131	<u>2.73</u>	110
Tuakau Bridge	12	117	68	19	400	92	1.48	80

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Faecal Coliforms (n/100 mL)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	2	1	1	7	1	<u>2.77</u>	2
Ohaaki Bridge	12	45	22	8	210	35	<u>2.14</u>	24
Ohakuri Tailrace Bridge	12	5	3	1	24	3	<u>1.89</u>	3
Whakamaru Tailrace	12	15	10	3	63	12	<u>2.04</u>	5
Waipapa Tailrace	12	20	14	1	64	20	1.23	16
Narrows Bridge	12	119	40	16	730	40	<u>2.34</u>	160
Horotiu Bridge	12	114	84	17	360	106	1.51	265
Huntly-Tainui Bridge	12	295	290	31	1000	250	1.41	480
Mercer Bridge	12	241	110	34	1400	166	<u>2.55</u>	330
Tuakau Bridge	12	150	87	22	540	134	1.53	190

Lithium (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.040	0.040	0.035	0.044	0.003	-0.51	0.040
Ohaaki Bridge	12	0.121	0.104	0.083	0.204	0.046	1.14	0.086
Ohakuri Tailrace Bridge	12	0.132	0.131	0.106	0.191	0.034	1.16	0.108
Whakamaru Tailrace	12	0.127	0.120	0.101	0.172	0.031	0.72	0.108
Waipapa Tailrace	12	0.109	0.113	0.082	0.143	0.027	0.12	0.095
Narrows Bridge	12	0.099	0.096	0.084	0.121	0.029	0.36	0.086
Horotiu Bridge	12	0.100	0.095	0.083	0.123	0.030	0.39	0.086
Huntly-Tainui Bridge	12	0.075	0.074	0.038	0.106	0.036	-0.04	0.067
Mercer Bridge	12	0.076	0.069	0.045	0.104	0.031	0.12	0.063
Tuakau Bridge	12	0.075	0.069	0.041	0.108	0.029	0.16	0.063

Nitrate/Nitrite Nitrogen (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.001	0.001	0.001	0.003	0.001	1.68	0.001
Ohaaki Bridge	12	0.031	0.032	0.017	0.051	0.014	0.42	0.025
Ohakuri Tailrace Bridge	12	0.051	0.035	0.001	0.134	0.079	0.56	0.045
Whakamaru Tailrace	12	0.056	0.037	0.004	0.162	0.071	0.99	0.037
Waipapa Tailrace	12	0.107	0.092	0.029	0.212	0.084	0.41	0.093
Narrows Bridge	12	0.147	0.122	0.024	0.321	0.157	0.53	0.117
Horotiu Bridge	12	0.165	0.132	0.027	0.351	0.143	0.53	0.150
Huntly-Tainui Bridge	12	0.328	0.282	0.061	0.793	0.228	0.93	0.266
Mercer Bridge	12	0.286	0.282	0.001	0.776	0.266	0.72	0.247
Tuakau Bridge	12	0.264	0.273	0.001	0.719	0.296	0.59	0.260

Nitrogen - Ammoniacal (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.01	0.01	0.01	0.02	0.00	<u>2.21</u>	0.005
Ohaaki Bridge	12	0.02	0.01	0.01	0.08	0.02	<u>2.35</u>	0.005
Ohakuri Tailrace Bridge	12	0.01	0.01	0.01	0.03	0.02	1.06	0.005
Whakamaru Tailrace	12	0.01	0.01	0.01	0.02	0.00	1.59	0.005
Waipapa Tailrace	12	0.02	0.01	0.01	0.08	0.02	<u>2.35</u>	0.010
Narrows Bridge	12	0.02	0.02	0.01	0.04	0.02	0.78	0.010
Horotiu Bridge	12	0.01	0.01	0.01	0.03	0.01	1.24	0.025
Huntly-Tainui Bridge	12	0.01	0.01	0.01	0.04	0.01	<u>2.19</u>	0.010
Mercer Bridge	12	0.01	0.01	0.01	0.03	0.01	<u>1.85</u>	0.005
Tuakau Bridge	12	0.01	0.01	0.01	0.02	0.01	<u>1.69</u>	0.005

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Nitrogen - Total Kjeldahl (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.06	0.06	0.03	0.11	0.04	0.29	0.07
Ohaaki Bridge	12	0.09	0.08	0.06	0.11	0.03	0.38	0.08
Ohakuri Tailrace Bridge	12	0.11	0.11	0.07	0.16	0.05	0.27	0.11
Whakamaru Tailrace	12	0.14	0.15	0.03	0.25	0.08	-0.09	0.13
Waipapa Tailrace	12	0.15	0.15	0.05	0.30	0.07	0.71	0.15
Narrows Bridge	12	0.24	0.23	0.14	0.45	0.05	1.65	0.21
Horotiu Bridge	12	0.25	0.24	0.12	0.42	0.07	0.71	0.24
Huntly-Tainui Bridge	12	0.29	0.28	0.23	0.42	0.05	1.41	0.27
Mercer Bridge	12	0.36	0.35	0.21	0.50	0.11	0.03	0.31
Tuakau Bridge	12	0.37	0.37	0.26	0.51	0.16	0.29	0.34

Nitrogen - Total (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.06	0.06	0.03	0.11	0.04	0.29	0.07
Ohaaki Bridge	12	0.12	0.12	0.09	0.16	0.03	0.34	0.11
Ohakuri Tailrace Bridge	12	0.16	0.14	0.08	0.29	0.06	1.10	0.15
Whakamaru Tailrace	12	0.20	0.20	0.03	0.27	0.10	-1.08	0.19
Waipapa Tailrace	12	0.25	0.24	0.16	0.37	0.11	0.31	0.25
Narrows Bridge	12	0.39	0.35	0.23	0.59	0.20	0.45	0.34
Horotiu Bridge	12	0.41	0.39	0.28	0.61	0.17	0.53	0.40
Huntly-Tainui Bridge	12	0.62	0.55	0.36	1.12	0.24	1.08	0.54
Mercer Bridge	12	0.65	0.58	0.37	1.09	0.21	1.05	0.60
Tuakau Bridge	12	0.63	0.61	0.31	1.11	0.23	0.90	0.60

pH (pH Units)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	7.7	7.7	7.3	7.9	0.1	-0.33	7.6
Ohaaki Bridge	12	7.2	7.2	6.5	7.7	0.3	-0.32	7.3
Ohakuri Tailrace Bridge	12	7.4	7.4	7.1	7.8	0.3	0.40	7.4
Whakamaru Tailrace	12	7.5	7.6	7.2	8.0	0.4	0.40	7.5
Waipapa Tailrace	12	7.5	7.6	7.2	7.8	0.3	-0.36	7.4
Narrows Bridge	12	7.7	7.7	7.4	8.0	0.3	0.23	7.5
Horotiu Bridge	12	7.6	7.7	7.2	7.8	0.2	-0.78	7.5
Huntly-Tainui Bridge	12	7.6	7.6	7.4	8.0	0.2	1.01	7.5
Mercer Bridge	12	7.6	7.7	7.2	8.0	0.3	-0.33	7.5
Tuakau Bridge	12	7.6	7.7	7.2	8.1	0.4	0.00	7.6

Phosphorus - Dissolved Reactive (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.006	0.006	0.002	0.011	0.001	0.64	0.006
Ohaaki Bridge	12	0.012	0.012	0.008	0.017	0.006	0.20	0.009
Ohakuri Tailrace Bridge	12	0.014	0.013	0.006	0.023	0.009	0.39	0.012
Whakamaru Tailrace	12	0.013	0.011	0.008	0.024	0.007	1.05	0.011
Waipapa Tailrace	12	0.016	0.014	0.011	0.027	0.008	0.84	0.014
Narrows Bridge	12	0.015	0.013	0.007	0.025	0.012	0.27	0.014
Horotiu Bridge	12	0.021	0.020	0.007	0.039	0.010	0.29	0.020
Huntly-Tainui Bridge	12	0.024	0.023	0.008	0.051	0.006	0.99	0.023
Mercer Bridge	12	0.018	0.018	0.006	0.035	0.007	0.83	0.017
Tuakau Bridge	12	0.017	0.017	0.006	0.034	0.009	0.68	0.016

Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range

Phosphorus - Total (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.007	0.006	0.002	0.016	0.002	1.21	0.006
Ohaaki Bridge	12	0.015	0.013	0.008	0.032	0.005	<u>1.88</u>	0.012
Ohakuri Tailrace Bridge	12	0.023	0.022	0.018	0.028	0.006	0.40	0.020
Whakamaru Tailrace	12	0.030	0.029	0.022	0.050	0.005	<u>1.96</u>	0.022
Waipapa Tailrace	12	0.031	0.031	0.025	0.041	0.008	0.54	0.026
Narrows Bridge	12	0.039	0.038	0.028	0.058	0.008	1.05	0.033
Horotiu Bridge	12	0.051	0.051	0.041	0.064	0.009	0.39	0.043
Huntly-Tainui Bridge	12	0.072	0.073	0.052	0.098	0.014	0.32	0.060
Mercer Bridge	12	0.085	0.081	0.062	0.121	0.031	0.61	0.068
Tuakau Bridge	12	0.083	0.081	0.061	0.114	0.025	0.66	0.070

Temperature (°C)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	14.9	14.7	10.2	19.2	6.0	0.04	14.3
Ohaaki Bridge	12	16.9	16.2	11.9	22.3	6.2	0.16	16.2
Ohakuri Tailrace Bridge	12	16.6	16.3	11.5	22.0	6.2	0.11	16.5
Whakamaru Tailrace	12	16.5	16.2	11.4	21.7	6.5	0.06	16.4
Waipapa Tailrace	12	16.2	16.1	11.1	20.6	6.4	-0.02	16.3
Narrows Bridge	12	16.1	16.0	10.6	20.7	6.6	-0.06	16.0
Horotiu Bridge	12	16.1	15.9	10.6	20.7	6.8	-0.05	16.1
Huntly-Tainui Bridge	12	16.2	16.0	10.5	21.1	7.2	-0.04	16.2
Mercer Bridge	12	17.1	17.1	11.2	22.0	7.5	-0.11	17.0
Tuakau Bridge	12	17.4	17.5	11.4	23.0	7.8	-0.06	17.1

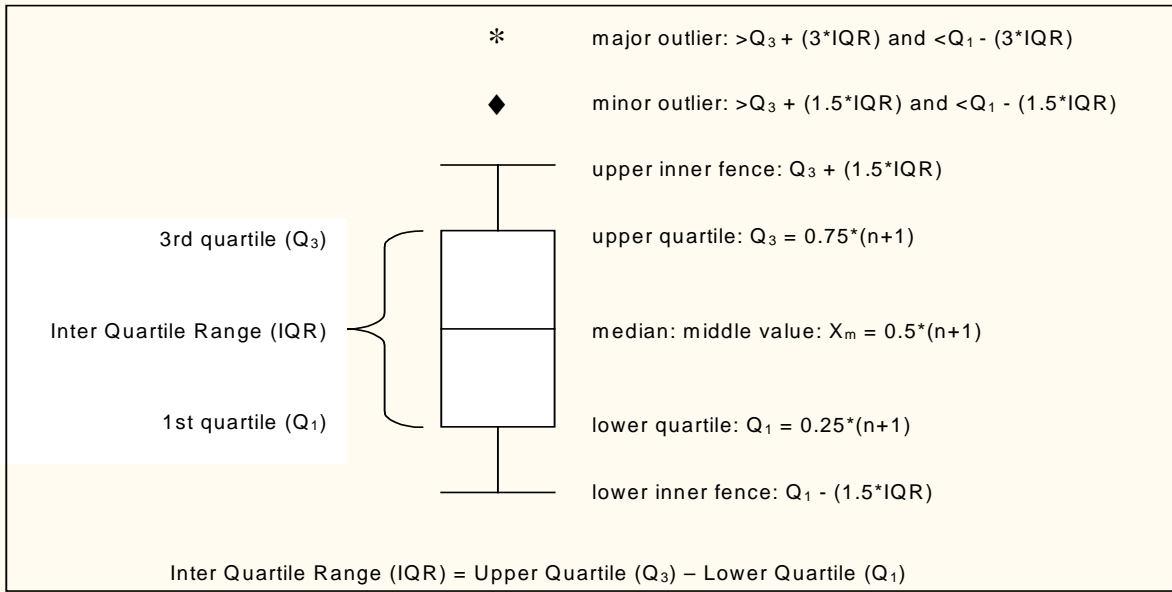
Dissolved Solids - Total (g m <sup>-3</sup> )								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	89	90	80	95	6	-0.74	88
Ohaaki Bridge	12	124	118	103	196	21	<u>2.00</u>	111
Ohakuri Tailrace Bridge	12	135	135	119	163	11	1.01	121
Whakamaru Tailrace	12	134	132	117	169	12	1.57	121
Waipapa Tailrace	12	125	130	106	151	18	0.26	119
Narrows Bridge	12	128	126	113	154	18	0.72	119
Horotiu Bridge	12	125	123	98	147	23	-0.05	119
Huntly-Tainui Bridge	12	118	120	92	134	20	-0.45	114
Mercer Bridge	12	124	122	109	143	18	0.31	117
Tuakau Bridge	12	123	122	108	142	15	0.23	117

Turbidity (NTU)								
Location	Count	Mean	Median	Min	Max	IQR	Skew	5 Yr Median
Taupo Control Gates	12	0.4	0.3	0.2	0.5	0.1	0.65	0.3
Ohaaki Bridge	12	0.6	0.5	0.4	0.9	0.4	0.38	0.6
Ohakuri Tailrace Bridge	12	1.0	1.1	0.6	1.4	0.4	-0.51	0.9
Whakamaru Tailrace	12	1.5	1.4	0.8	2.6	0.7	0.82	1.2
Waipapa Tailrace	12	1.8	1.6	0.7	3.9	1.0	1.07	1.4
Narrows Bridge	12	3.4	3.0	1.4	7.0	2.4	0.82	2.3
Horotiu Bridge	12	3.9	3.3	1.7	7.4	2.5	0.78	2.9
Huntly-Tainui Bridge	12	7.3	6.2	2.6	17	4.0	1.21	5.1
Mercer Bridge	12	10.1	9.6	4.3	17	7.3	0.27	7.5
Tuakau Bridge	12	10.2	9.1	5.5	21.7	4.9	1.29	8.8

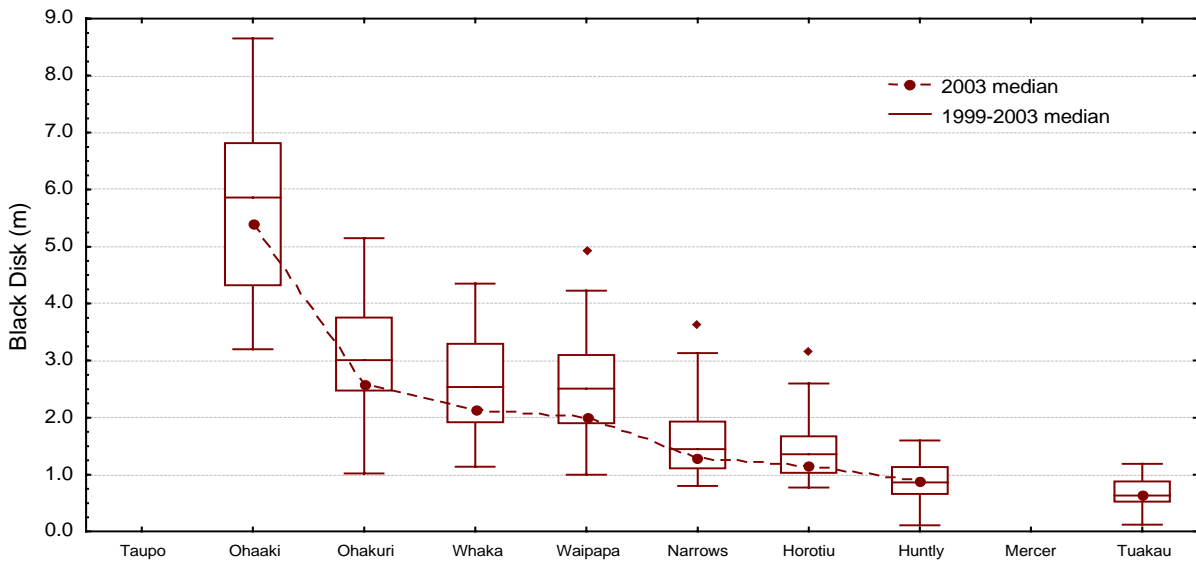
Skew = skewness. Underlined values = non-normal distribution. IQR = Inter Quartile Range



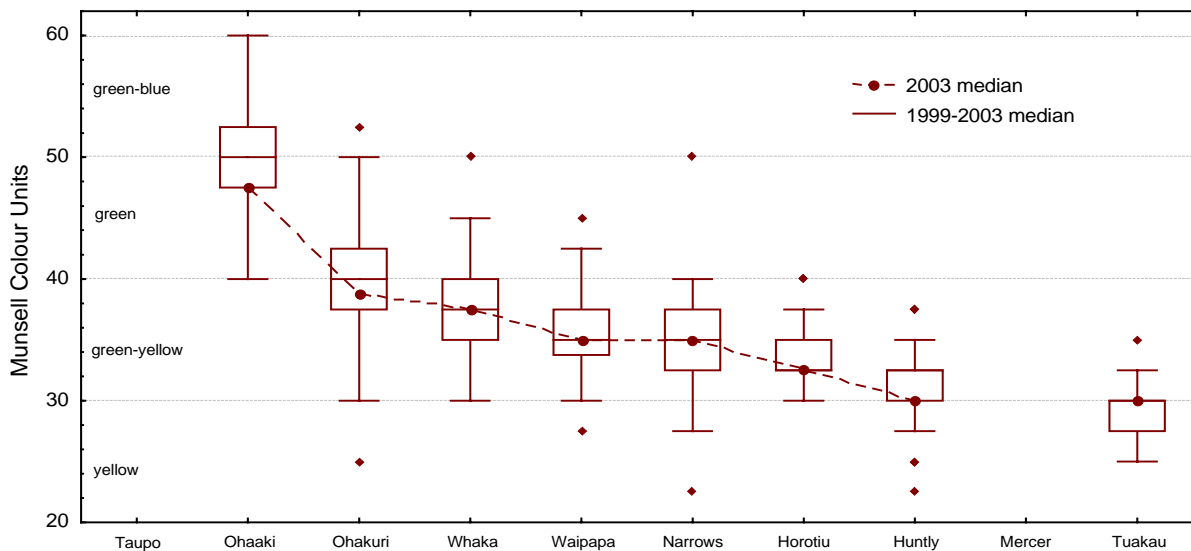
### Boxplots are used to present data



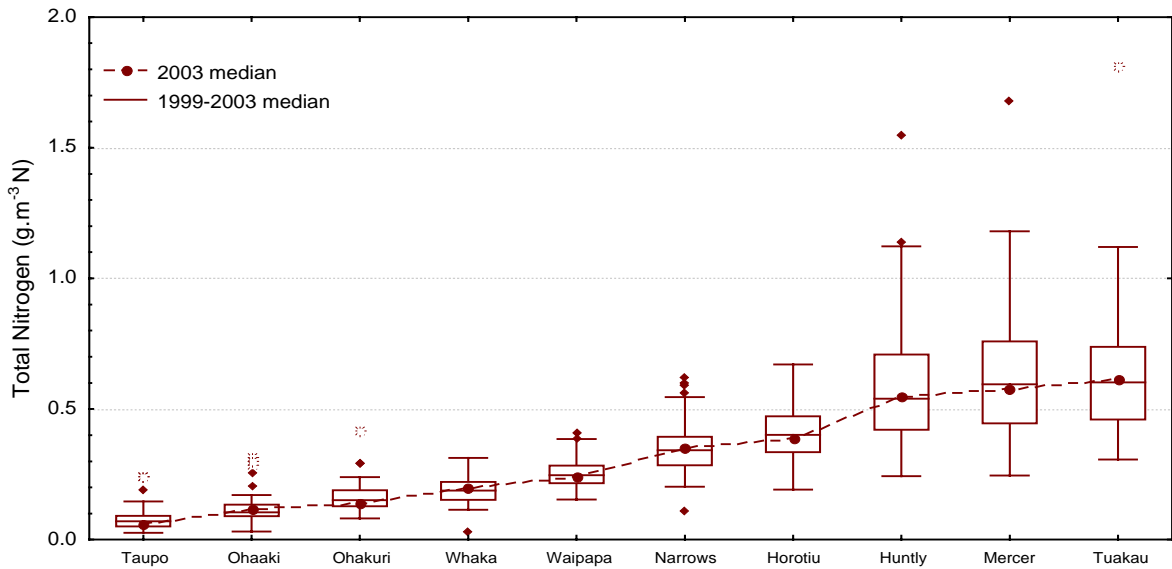
**Black Disk, 1999-2003 Data**



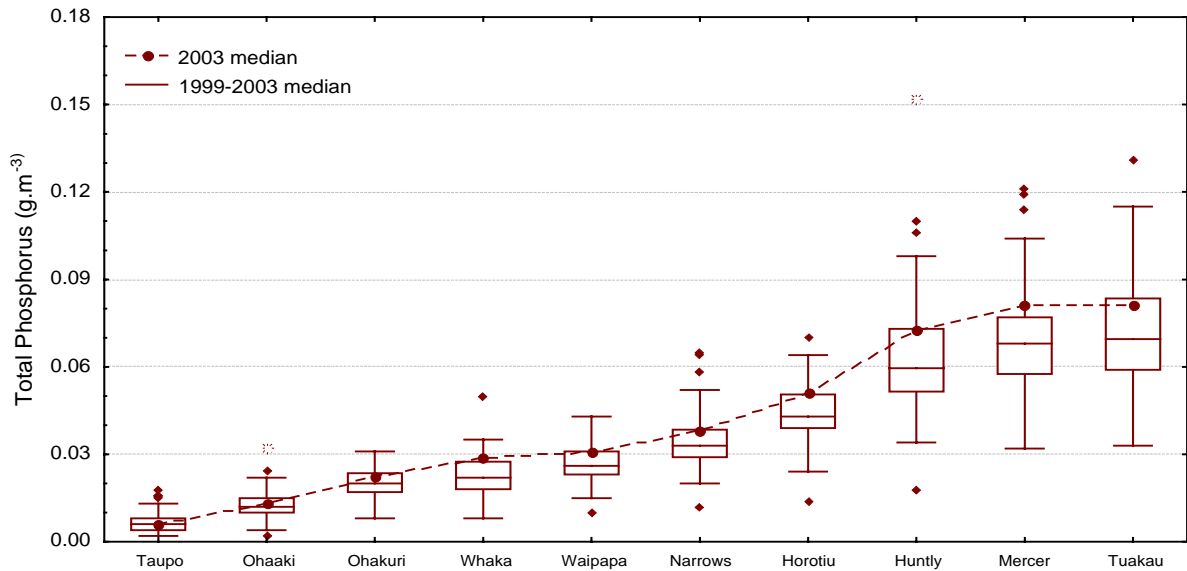
**Colour, 1999-2003 Data**



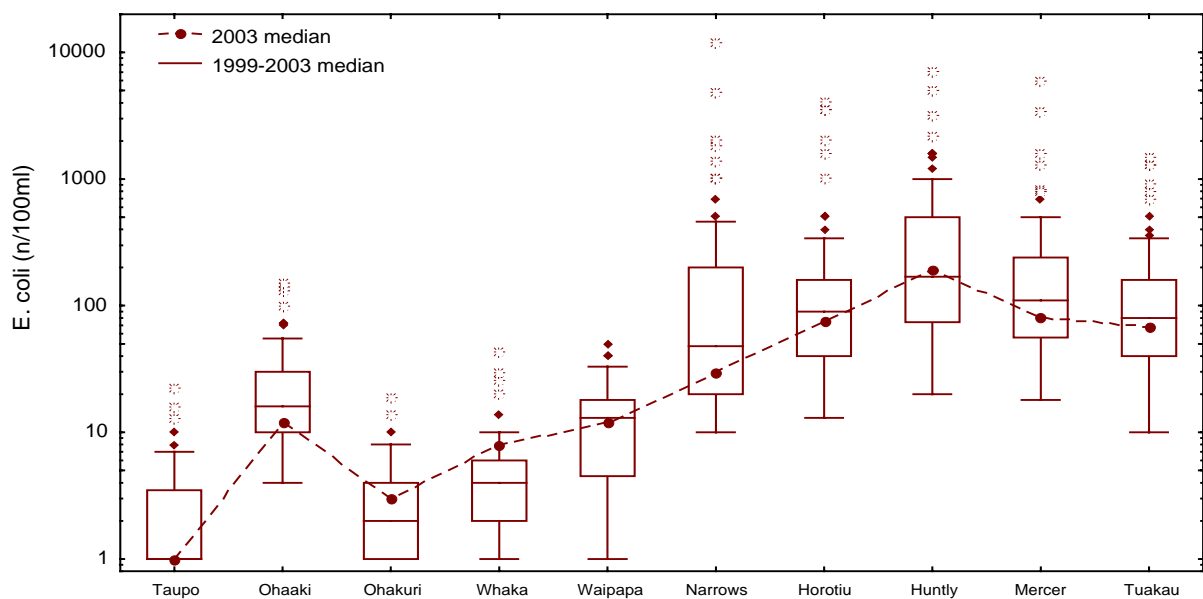
**Total Nitrogen, 1999-2003 Data**



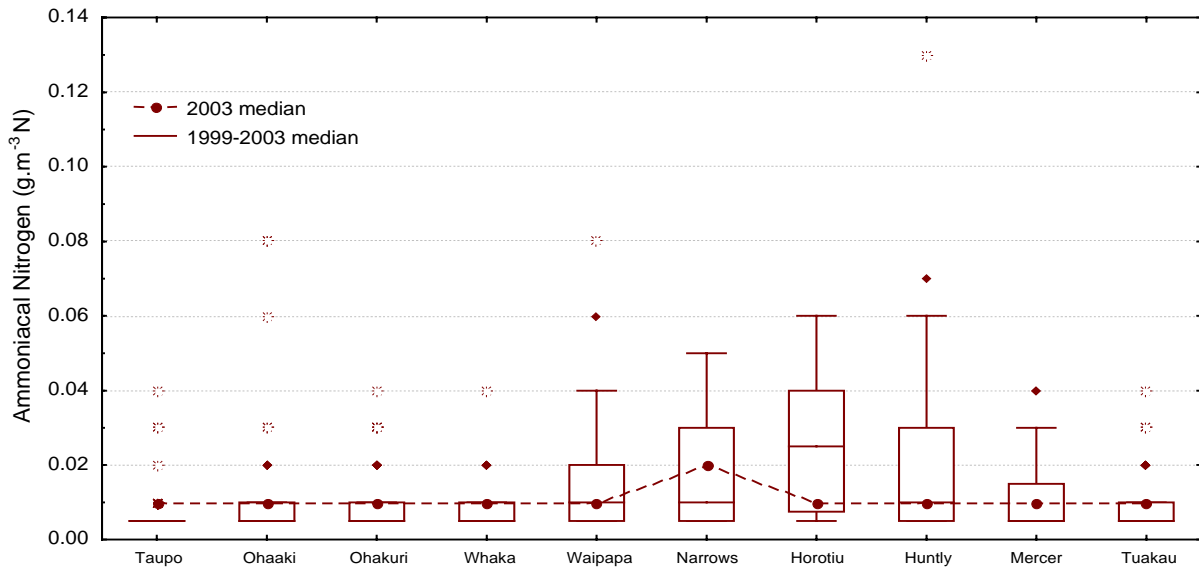
**Total Phosphorus, 1999-2003 Data**



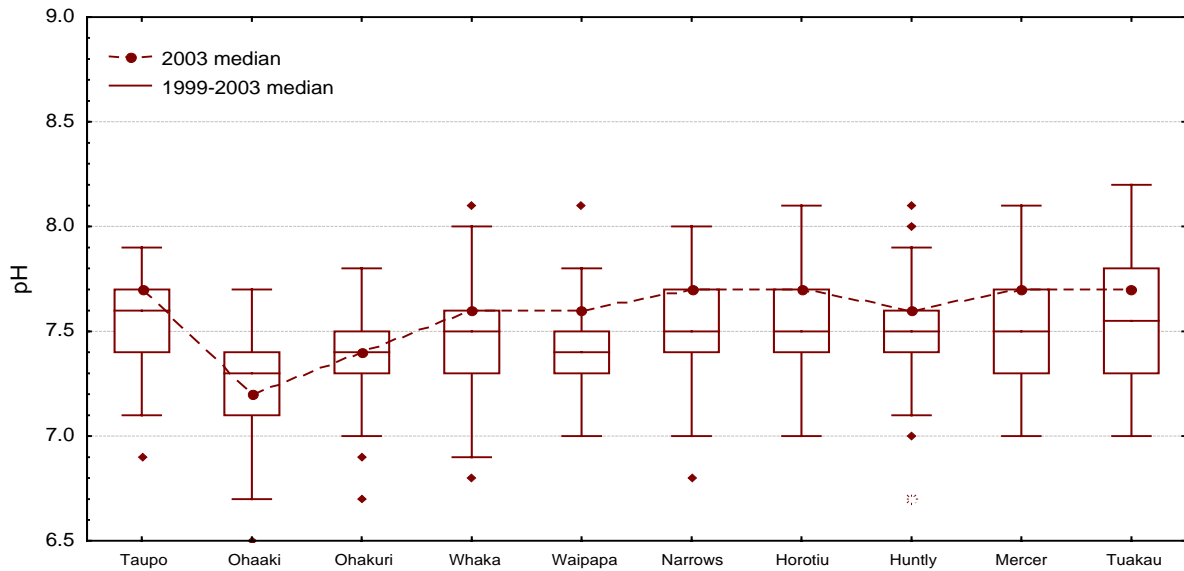
**E.coli, 1999-2003 Data**



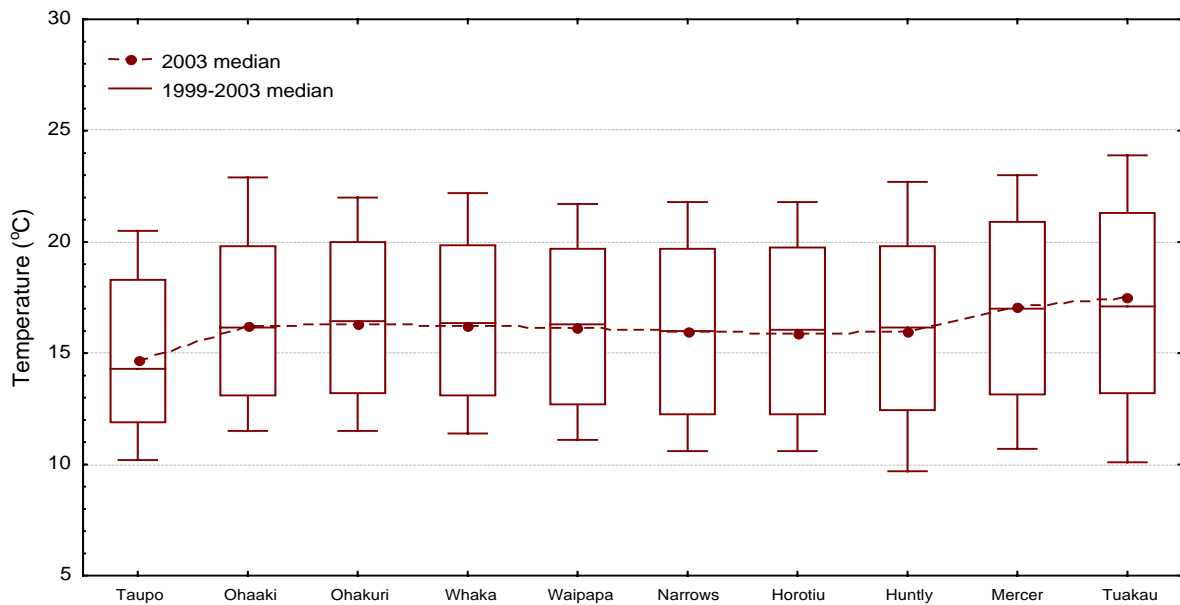
Ammoniacal Nitrogen, 1999-2003 Data



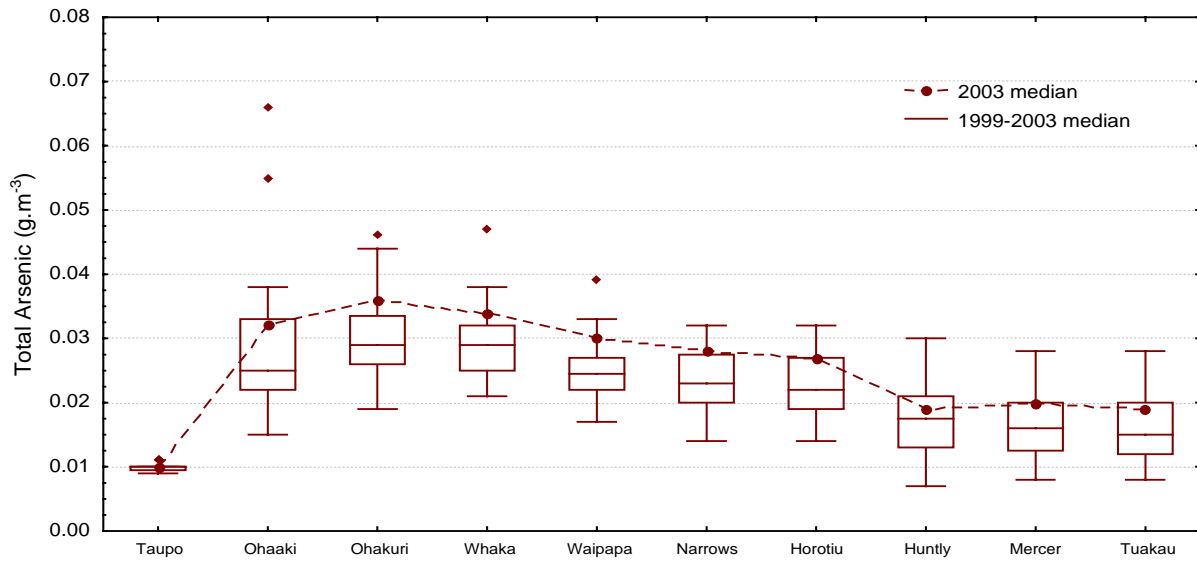
pH, 1999-2003 Data



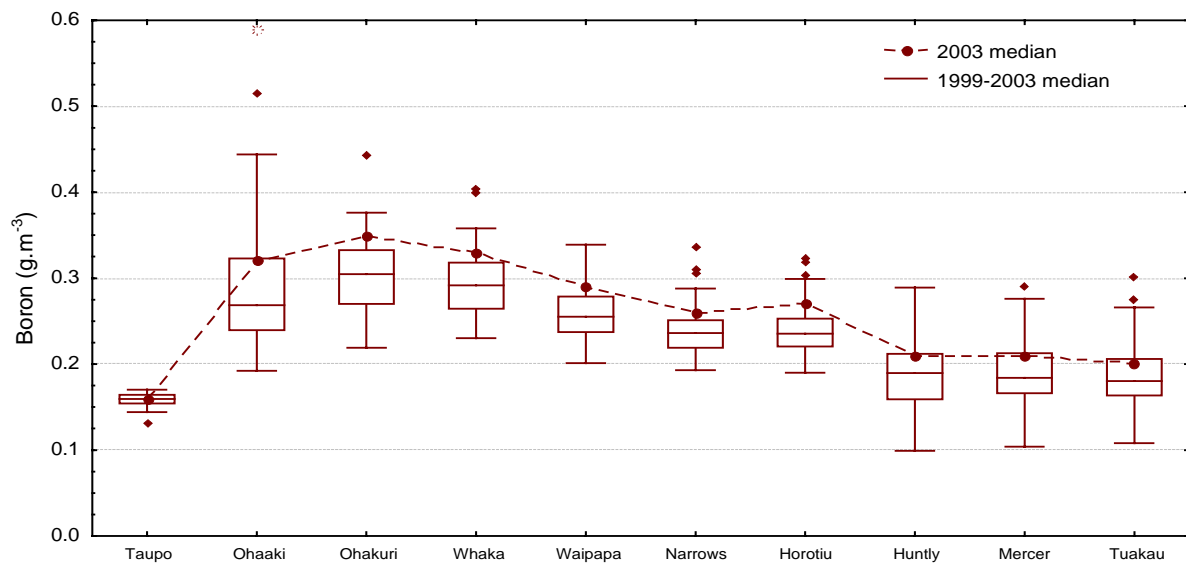
Temperature, 1999-2003 Data



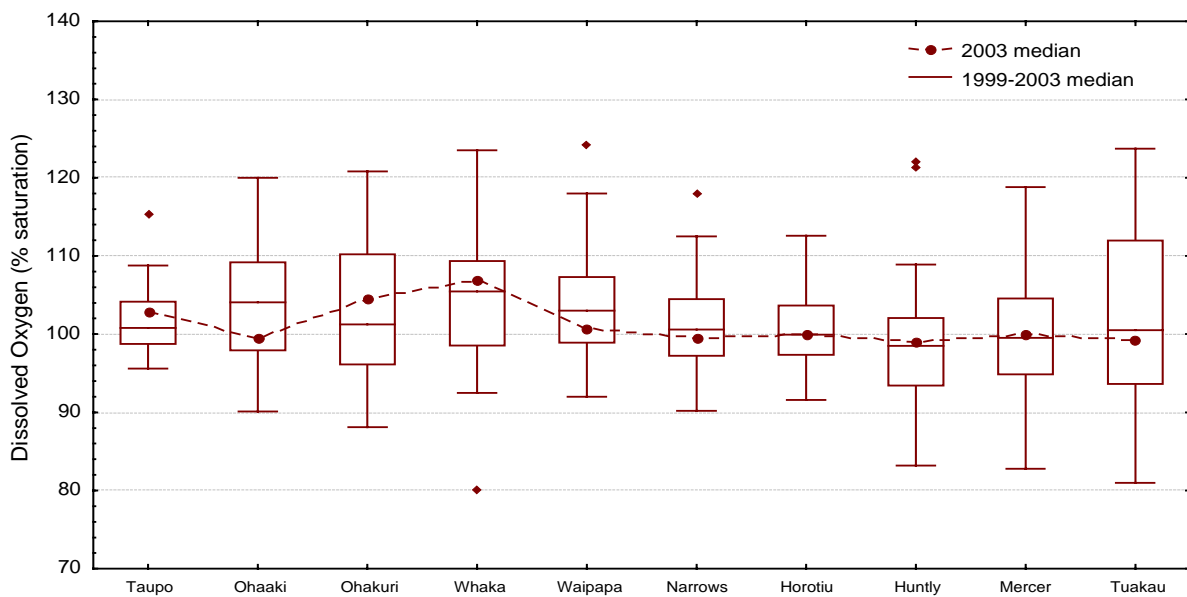
**Total Arsenic, 1999-2003 Data**



**Boron, 1999-2003 Data**



**Dissolved Oxygen, 1999-2003 Data**



**Table 3: Samples (Year 2003) complying with the ‘Satisfactory’ Water Quality Guidelines and Standards. n = 12.**

Location	ECOLOGICAL HEALTH							HUMAN USES						
								Recreation				water supply	drinking water	
	DO	pH	Turb	NH <sub>4</sub> N	Temp	TP	TN	Bk <sup>1</sup> Disk	E coli	Median E coli	Median Ent	CHLa	As	B
Taupo Gates	12	12	12	12	9	12	12	–	12	Y	Y	12	8	12
Ohaaki Bridge	12	12	12	12	5	12	12	12/12	12	Y	Y	12	0	12
Ohakuri Tailrace Br	12	12	12	12	5	12	12	12/12	12	Y	Y	12	0	12
Whakamaru Tailrace	12	12	12	12	5	11	12	10/12	12	Y	Y	12	0	12
Waipapa Tailrace	12	12	12	12	6	11	12	9/11	12	Y	Y	11	0	12
Hamilton – Narrows	12	12	10	12	6	8	9	3/12	12	Y	Y	9	0	12
Horotiu Bridge	12	12	9	12	6	0	9	3/12	12	Y	Y	7	0	12
Huntly – Tainui Br	12	12	5	12	5	0	5	0/11	10	N	Y	8	1	12
Mercer Bridge	12	12	1	12	4	0	3	–	11	Y	Y	8	0	12
Tuakau Bridge	12	12	0	12	4	0	4	0/12	12	Y	Y	5	1	12

<sup>1</sup> samples complying with the baseflow water clarity guideline from the number of samples measured when flow was below the upper decile of all flows

**Table 4: Samples (Year 2003) complying with the ‘Excellent’ Water Quality Guidelines and Standards. n = 12.**

Location	ECOLOGICAL HEALTH							HUMAN USES						
								Recreation				water supply	Drinking water	
	DO	pH	Turb	NH <sub>4</sub> N	Temp	TP	TN	Bk <sup>1</sup> Disk	E coli	Median E coli	Median Ent	CHLa	As	B
Taupo Gates	12	12	12	12	2	10	11	–	12	Y	Y	12	n/a	n/a
Ohaaki Bridge	12	10	12	12	2	1	3	10/12	10	Y	N	12	n/a	n/a
Ohakuri Tailrace Br	11	12	12	12	2	0	1	1/12	12	Y	Y	6	n/a	n/a
Whakamaru Tailrace	12	12	10	12	2	0	1	0/12	12	Y	Y	4	n/a	n/a
Waipapa Tailrace	12	12	8	12	2	0	0	0/11	12	Y	Y	3	n/a	n/a
Hamilton – Narrows	12	12	2	12	2	0	0	0/12	9	N	N	1	n/a	n/a
Horotiu Bridge	12	12	1	12	2	0	0	0/12	5	N	N	0	n/a	n/a
Huntly – Tainui Br	11	12	0	12	1	0	0	0/11	3	N	N	2	n/a	n/a
Mercer Bridge	11	12	0	12	1	0	0	–	3	N	N	1	n/a	n/a
Tuakau Bridge	10	11	0	12	1	0	0	0/12	5	N	N	0	n/a	n/a

<sup>1</sup> samples complying with the baseflow water clarity guideline from the number of samples measured when flow was below the upper decile of all flows

DATE	TIME*	FLOW	BDISK	COLOR	COND	PH	TEMP	DO	PCDO	BOD5	TURB	TDS	NNN	NO3-N	NH4-N
dd/mm/yy	HH:MM	m <sup>3</sup> /s	m	units	mS/m	units	°C	g/m <sup>3</sup>	%Sat	g/m <sup>3</sup>	NTU	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>
Satisfactory Water		>1.6	-	-	6.5-9	<12 (May-Sep)	>80	-	<5	-	-	-	-	-	<0.88
Quality Guideline/Standard						<20 (Oct-Apr)									

**1131-127** UD=254 m<sup>3</sup>/s (Flows from "Reids Farm")

**Waikato River @ Taupo Control Gates**

07/01/03	8:15	92	-	-	11.6	7.6	19.2	9.4	105.2	< 0.4	0.38	83	< 0.002	< 0.002	< 0.01
04/02/03	8:10	178	-	-	11.8	7.6	19.2	9.3	104.2	< 0.4	0.24	93	0.002	0.002	< 0.01
04/03/03	7:50	172	-	-	11.6	7.7	17.9	9.5	104.7	1.7	0.32	95	0.002	0.002	< 0.01
01/04/03	8:22	112	-	-	12.1	7.5	18.2	9.4	106.1	< 0.4	0.32	80	0.003	0.002	< 0.01
06/05/03	9:00	106	-	-	11.9	7.3	<u>15.5</u>	9.6	99.7	< 0.4	0.29	87	< 0.002	< 0.002	0.02
04/06/03	8:30	183	-	-	12.4	7.7	<u>13.8</u>	10.0	99.9	0.6	0.50	93	< 0.002	< 0.002	< 0.01
01/07/03	8:53	192	-	-	11.8	7.7	<u>12.5</u>	9.9	99.2	0.4	0.53	88	< 0.002	< 0.002	0.01
05/08/03	8:45	198	-	-	12.3	7.6	10.2	10.4	97.2	0.8	0.26	88	< 0.002	< 0.002	< 0.01
02/09/03	9:20	96	-	-	12.6	7.6	10.9	10.7	102.9	0.5	0.44	93	< 0.002	< 0.002	< 0.01
02/10/03	8:00	131	-	-	13.1	7.7	11.7	10.1	98.1	< 0.4	0.37	92	< 0.002	< 0.002	< 0.01
04/11/03	7:56	117	-	-	12.4	7.9	13.1	10.3	102.8	0.4	0.31	90	< 0.002	< 0.002	0.01
02/12/03	8:10	103	-	-	12.4	7.9	16.2	10.0	105.6	0.5	0.24	89	< 0.002	< 0.002	< 0.01

**1131-105** UD=274 m<sup>3</sup>/s (Flows from Ohaaki Bridge Recorder, +/- 20%)

**Waikato River @ Ohaaki Br**

07/01/03	9:20	170	4.3	47.5	14.8	7.3	<u>21.3</u>	8.6	100.2	0.6	0.88	107	0.017	0.016	0.02
04/02/03	9:10	161	6.6	57.5	14.5	7.3	<u>21.1</u>	8.7	101.9	< 0.4	0.45	115	0.019	0.019	< 0.01
04/03/03	8:30	144	5.4	55.0	15.3	7.0	18.9	8.9	99.0	0.4	0.41	127	0.030	0.027	< 0.01
01/04/03	9:32	108	4.8	55.0	30.0	6.5	<u>22.3</u>	7.5	90.1	< 0.4	0.91	196	0.036	0.033	0.08
06/05/03	10:10	119	6.5	50.0	16.8	7.1	<u>16.5</u>	10.7	109.9	0.4	0.43	120	0.036	0.035	< 0.01
04/06/03	9:15	144	3.4	45.0	18.3	6.9	<u>15.8</u>	9.4	98.8	0.9	0.75	126	0.036	0.036	0.01
01/07/03	9:43	93	6.0	47.5	20.8	7.0	<u>15.7</u>	9.7	98.7	< 0.4	0.80	141	0.051	0.051	0.03
05/08/03	9:35	217	4.0	45.0	15.5	7.3	11.9	10.9	96.0	0.9	0.42	104	0.023	0.022	< 0.01
02/09/03	10:15	125	4.9	50.0	16.9	7.3	<u>12.6</u>	10.8	107.2	0.6	0.84	111	0.033	0.033	< 0.01
02/10/03	8:40	157	5.4	45.0	17.2	7.1	13.5	10.0	100.2	< 0.4	0.53	103	0.024	0.024	0.01
04/11/03	8:47	222	6.2	45.0	14.9	7.7	14.1	11.0	112.1	0.5	0.48	107	0.022	< 0.002	0.01
02/12/03	8:56	106	5.4	45.0	18.8	7.6	18.7	8.9	98.2	0.5	0.47	129	0.045	0.043	0.02

**1131-107** UD=308 m<sup>3</sup>/s (Flows from Ohakuri Dam - Total)

**Waikato River @ Ohakuri Tailrace Br**

07/01/03	10:40	134	1.6	37.5	18.1	7.5	<u>22.0</u>	9.4	111.0	1.4	1.28	137	0.019	0.018	< 0.01
04/02/03	10:08	152	2.5	40.0	16.2	7.5	<u>21.2</u>	9.9	114.2	< 0.4	1.41	131	< 0.002	< 0.002	< 0.01
04/03/03	9:20	189	2.9	40.0	16.7	7.1	<u>20.0</u>	8.4	95.5	0.6	0.89	138	0.026	0.026	0.01
01/04/03	10:26	116	2.8	37.5	18.8	7.3	19.9	8.2	91.8	< 0.4	0.58	163	0.044	0.042	< 0.01
06/05/03	11:15	166	3.0	37.5	19.2	7.1	<u>17.0</u>	10.6	112.0	< 0.4	0.68	135	0.078	0.077	0.03
04/06/03	10:20	162	2.4	40.0	21.0	7.3	<u>14.9</u>	8.8	88.6	0.7	1.01	146	0.120	0.117	< 0.01
01/07/03	10:50	171	5.0	42.5	17.9	7.2	<u>13.2</u>	9.5	95.7	0.6	1.12	136	0.134	0.132	0.03
05/08/03	10:35	255	2.8	40.0	16.5	7.4	11.5	10.6	100.9	0.9	0.63	128	0.059	0.057	< 0.01
02/09/03	11:10	165	2.3	40.0	17.6	7.5	<u>12.3</u>	11.1	108.2	0.7	1.17	121	0.023	0.022	< 0.01
02/10/03	9:40	143	2.3	37.5	19.4	7.4	14.4	9.4	95.2	0.7	1.17	135	0.101	0.095	0.03
04/11/03	9:45	276	2.7	37.5	16.6	7.8	15.5	10.7	111.8	0.5	1.19	119	0.003	< 0.002	< 0.01
02/12/03	10:00	196	2.4	35.0	17.1	7.8	17.6	10.3	110.7	1.0	1.17	126	< 0.002	< 0.002	0.01

**1131-147** UD=311 m<sup>3</sup>/s (Flows from Whakamaru Dam - Total)

**Waikato River @ Whakamaru Tailrace**

07/01/03	11:40	156	<u>1.2</u>	35.0	19.7	8.0	<u>21.7</u>	9.4	109.1	1.2	2.58	137	0.020	0.020	0.01
04/02/03	10:55	149	1.9	37.5	15.6	7.5	<u>20.6</u>	9.8	112.1	< 0.4	2.50	131	0.004	0.004	< 0.01
04/03/03	9:55	181	2.1	40.0	15.7	7.3	<u>20.6</u>	9.4	107.1	0.6	1.80	132	0.011	0.010	< 0.01
01/04/03	11:05	132	1.8	35.0	18.2	7.3	19.8	9.6	106.7	0.6	0.80	169	0.037	0.033	< 0.01
06/05/03	12:05	197	2.6	40.0	18.9	7.2	<u>16.6</u>	9.4	98.8	0.8	0.89	142	0.115	0.114	< 0.01
04/06/03	11:00	214	2.3	40.0	19.8	7.4	<u>14.5</u>	9.5	97.2	0.7	1.03	137	0.162	0.161	< 0.01
01/07/03	11:48	219	3.8	40.0	17.5	7.3	<u>13.0</u>	9.9	98.3	< 0.4	1.26	135	0.155	0.153	< 0.01
05/08/03	11:20	279	1.8	37.5	16.0	7.6	11.4	11.0	102.7	1.0	0.95	117	0.057	0.056	< 0.01
02/09/03	12:00	250	2.1	37.5	16.4	7.6	<u>12.2</u>	11.6	112.7	1.2	1.45	122	0.004	0.004	< 0.01
02/10/03	10:20	167	<u>1.3</u>	32.5	18.8	7.7	14.4	10.7	107.6	0.9	1.50	127	0.049	0.048	0.02
04/11/03	10:31	234	2.4	35.0	16.9	7.7	15.7	11.0	114.5	0.5	1.37	129	0.036	0.032	< 0.01
02/12/03	10:57	205	2.7	37.5	16.7	7.7	17.9	9.9	105.9	0.9	1.58	124	0.022	0.021	0.02

Note: < = less than value stated

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

\* New Zealand Standard Time

() black disk measurements taken in flows above upper decile value – don't assess for compliance

TKN g/m <sup>3</sup>	TN g/m <sup>3</sup>	DRP g/m <sup>3</sup>	TP g/m <sup>3</sup>	CL g/m <sup>3</sup>	AS g/m <sup>3</sup>	B g/m <sup>3</sup>	LI g/m <sup>3</sup>	A340F /cm	A440F /cm	ENT cfu/100ml	FC cfu/100ml	E coli cfu/100ml	CHLA g/m <sup>3</sup>	DOC g/m <sup>3</sup>	TOC g/m <sup>3</sup>
-	<0.5	-	<0.04	-	<0.01	<1.4	-	-	-	<77	-	<550	<0.02		
0.09	0.09	0.005	0.013	9.6	0.010	0.16	0.039	0.013	< 0.002	2	< 2	< 2	< 0.003	0.6	1.1
< 0.05	0.03	0.006	0.004	9.4	0.010	0.17	0.042	0.006	< 0.002	< 2	< 2	< 2	< 0.003	0.7	1.0
0.05	0.05	< 0.004	0.005	9.9	0.010	0.16	0.040	< 0.002	< 0.002	< 2	< 2	< 2	< 0.003	0.7	1.0
< 0.05	0.03	0.006	0.008	9.0	0.010	0.16	0.035	0.002	< 0.002	4	< 1	< 1	< 0.003	1.0	1.0
0.11	0.11	0.011	0.016	10.1	0.010	0.15	0.040	0.005	< 0.002	1	1	1	< 0.003	0.5	1.2
0.08	0.08	0.005	< 0.004	8.4	<u>0.011</u>	0.17	0.044	< 0.002	< 0.002	< 1	< 1	< 1	< 0.003	0.4	0.9
0.09	0.09	0.006	0.006	8.9	0.010	0.16	0.042	0.003	< 0.002	2	1	1	< 0.003	0.8	1.1
0.05	0.05	0.007	0.006	8.6	0.010	0.17	0.041	0.003	< 0.002	< 1	< 1	< 1	< 0.003	0.4	0.8
0.05	0.05	0.006	0.006	9.9	<u>0.011</u>	0.15	0.038	< 0.002	< 0.002	2	2	2	< 0.003	0.9	1.4
0.06	0.06	0.005	0.007	9.8	<u>0.011</u>	0.16	0.039	0.005	< 0.002	7	7	5	< 0.003	0.5	0.8
0.07	0.07	0.005	0.007	8.8	<u>0.011</u>	0.16	0.043	< 0.002	< 0.002	5	2	1	< 0.003	0.5	0.9
0.06	0.06	< 0.004	0.006	9.4	0.010	0.17	0.040	< 0.002	< 0.002	2	1	1	< 0.003	1.0	1.4
0.11	0.13	0.011	0.013	19.9	<u>0.029</u>	0.29	0.094	0.013	0.002	38	210	150	< 0.003	0.7	1.0
0.11	0.13	0.014	0.012	19.6	<u>0.031</u>	0.30	0.098	0.004	< 0.002	24	100	74	0.003	0.3	0.9
0.06	0.09	0.017	0.015	22.8	<u>0.033</u>	0.32	0.110	< 0.002	< 0.002	30	26	12	< 0.003	0.7	1.2
0.08	0.12	0.011	0.032	55.4	<u>0.066</u>	0.59	0.204	0.015	0.003	29	59	12	< 0.003	0.6	1.0
0.08	0.12	0.012	0.008	23.8	<u>0.035</u>	0.31	0.110	0.003	< 0.002	8	26	16	< 0.003	0.4	0.9
0.07	0.11	0.008	0.011	22.8	<u>0.037</u>	0.44	0.145	0.002	< 0.002	10	35	34	< 0.003	< 0.3	1.0
0.11	0.16	0.016	0.016	35.8	<u>0.055</u>	0.52	0.195	0.003	0.002	9	9	9	< 0.003	1.0	1.1
0.07	0.09	0.009	0.011	16.8	<u>0.025</u>	0.28	0.088	0.002	< 0.002	3	8	5	0.003	0.4	0.8
0.09	0.12	0.014	0.012	20.9	<u>0.030</u>	0.30	0.095	0.004	< 0.002	15	11	10	< 0.003	0.8	1.7
0.09	0.11	0.009	0.015	21.1	<u>0.028</u>	0.32	0.095	0.005	< 0.002	4	14	10	< 0.003	0.5	0.8
0.07	0.09	0.009	0.011	15.6	<u>0.025</u>	0.26	0.083	0.002	< 0.002	8	18	11	< 0.003	0.6	1.0
0.08	0.13	0.016	0.020	27.0	<u>0.038</u>	0.43	0.135	0.005	< 0.002	6	18	17	< 0.003	1.0	1.3
0.13	0.15	0.010	0.026	27.6	<u>0.043</u>	0.38	0.145	0.016	0.004	< 1	< 2	< 2	0.006	0.6	1.2
0.08	0.08	0.012	0.020	23.4	<u>0.036</u>	0.35	0.125	0.005	< 0.002	< 2	4	4	0.009	0.6	1.3
0.11	0.14	0.023	0.021	27.1	<u>0.038</u>	0.35	0.131	0.004	< 0.002	< 2	2	< 2	0.003	0.5	1.0
0.07	0.11	0.012	0.023	25.6	<u>0.037</u>	0.37	0.137	0.008	0.002	< 1	3	3	0.004	0.7	1.1
0.09	0.17	0.017	0.020	28.4	<u>0.046</u>	0.37	0.144	0.005	< 0.002	3	4	4	0.003	0.3	0.9
0.07	0.19	0.023	0.025	28.0	<u>0.044</u>	0.44	0.191	0.004	< 0.002	1	2	2	< 0.003	0.6	1.1
0.16	0.29	0.020	0.026	24.7	<u>0.035</u>	0.36	0.143	0.007	0.003	5	1	< 1	< 0.003	1.0	1.2
0.08	0.14	0.010	0.021	18.9	<u>0.027</u>	0.32	0.106	0.003	< 0.002	< 1	< 1	< 1	0.004	0.5	0.9
0.12	0.14	0.013	0.020	22.6	<u>0.030</u>	0.30	0.110	0.005	< 0.002	8	4	3	0.007	1.0	1.8
0.12	0.22	0.015	0.028	24.8	<u>0.035</u>	0.34	0.130	0.009	< 0.002	7	24	19	0.005	0.6	1.1
0.11	0.11	0.006	0.018	18.9	<u>0.032</u>	0.31	0.110	0.005	< 0.002	1	1	1	0.013	0.7	1.1
0.13	0.13	0.008	0.022	21.6	<u>0.029</u>	0.32	0.108	0.006	< 0.002	1	16	14	0.011	1.1	1.5
0.25	0.27	0.011	<u>0.050</u>	29.5	<u>0.047</u>	0.40	0.161	0.019	0.003	10	22	20	< 0.003	0.5	1.3
< 0.05	0.03	0.011	0.030	21.7	<u>0.034</u>	0.31	0.116	0.007	< 0.002	33	30	30	0.017	0.4	1.5
0.19	0.20	0.015	0.025	23.0	<u>0.034</u>	0.32	0.118	0.005	< 0.002	25	12	8	0.010	0.5	1.4
0.11	0.15	0.013	0.026	23.7	<u>0.035</u>	0.34	0.131	0.006	< 0.002	3	4	4	0.004	0.9	1.0
0.14	0.26	0.017	0.026	28.4	<u>0.036</u>	0.36	0.145	0.007	< 0.002	3	7	7	0.004	0.3	1.1
0.10	0.26	0.024	0.029	25.8	<u>0.038</u>	0.40	0.172	0.007	< 0.002	1	3	2	0.006	< 0.3	1.0
0.11	0.27	0.019	0.025	23.9	<u>0.032</u>	0.35	0.136	0.006	< 0.002	5	9	8	< 0.003	1.2	1.2
0.09	0.15	0.010	0.035	17.9	<u>0.024</u>	0.30	0.101	0.004	< 0.002	1	10	8	0.007	0.5	0.9
0.17	0.17	0.009	0.022	21.4	<u>0.028</u>	0.28	0.103	0.006	< 0.002	8	3	3	0.011	1.0	2.2
0.20	0.25	0.009	0.028	24.3	<u>0.033</u>	0.34	0.122	0.011	0.002	7	63	43	0.018	0.7	1.3
0.15	0.19	0.008	0.030	19.8	<u>0.034</u>	0.30	0.115	0.006	< 0.002	1	12	10	0.012	0.6	1.1
0.18	0.20	0.009	0.030	21.1	<u>0.032</u>	0.31	0.105	0.009	< 0.002	1	6	5	0.011	1.2	1.5

Note: < = less than value stated

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

\* New Zealand Standard Time

() black disk measurements taken in flows above upper decile value – don't assess for compliance

DATE	TIME*	FLOW	BDISK	COLOR	COND	PH	TEMP	DO	PCDO	BOD5	TURB	TDS	NNN	NO3-N	NH4-N
dd/mm/yy	HH:MM	m <sup>3</sup> /s	m	units	mS/m	units	°C	g/m <sup>3</sup>	%Sat	g/m <sup>3</sup>	NTU	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>
Satisfactory Water		>1.6	-	-	6.5-9	<12 (May-Sep)	>80	-	<5	-	-	-	-	<0.88	
Quality Guideline/Standard						<20 (Oct-Apr)									

**1131-143** UD=341 m<sup>3</sup>/s (Flows from Waipapa Dam - Total)

**Waikato River @ Waipapa Tailrace**

07/01/03	12:40	245	1.7	35.0	17.4	7.6	<u>20.6</u>	8.9	99.3	1.1	2.82	134	0.073	0.071	0.08
04/02/03	11:40	134	<u>1.6</u>	35.0	15.6	7.6	<u>20.2</u>	9.4	103.2	0.9	3.93	129	0.031	0.031	< 0.01
04/03/03	10:40	193	2.2	37.5	16.6	7.6	<u>20.1</u>	8.9	99.2	1.3	2.52	131	0.029	0.027	0.02
01/04/03	11:38	161	1.7	35.0	17.4	7.3	19.5	9.5	104.0	< 0.4	1.40	151	0.127	0.121	0.03
06/05/03	12:45	198	2.0	37.5	17.5	7.2	<u>16.3</u>	9.7	100.0	< 0.4	1.03	131	0.152	0.151	< 0.01
04/06/03	11:30	222	2.0	37.5	17.4	7.3	<u>14.3</u>	9.8	98.9	0.8	1.50	131	0.200	0.198	< 0.01
01/07/03	12:31	261	2.8	32.5	16.2	7.2	<u>12.7</u>	9.8	96.2	< 0.4	1.61	130	0.212	0.210	0.01
05/08/03	12:00	260	2.1	37.5	15.7	7.5	11.1	10.9	99.7	0.8	0.68	114	0.102	0.100	< 0.01
02/09/03	12:30	282	1.8	35.0	16.6	7.6	11.9	11.3	107.3	0.9	1.67	108	0.052	0.051	< 0.01
02/10/03	10:55	196	<u>1.3</u>	30.0	16.2	7.6	14.1	10.2	101.1	0.8	2.02	106	0.141	0.137	0.02
04/11/03	11:10	343	(2.6)	35.0	16.8	7.7	15.9	10.3	106.4	< 0.4	1.24	117	0.081	0.078	0.01
02/12/03	11:40	230	2.5	35.0	15.0	7.8	17.2	10.1	105.6	0.9	1.75	113	0.081	0.081	0.01

**1131-101** UD=343 m<sup>3</sup>/s (Flows from Karapiro Dam - Total)

**Waikato River @ Narrows Br**

08/01/03	8:00	147	<u>1.6</u>	37.5	14.5	8.0	<u>20.7</u>	8.9	98.2	1.3	<u>6.97</u>	113	0.079	0.076	< 0.01
04/02/03	7:40	162	<u>1.4</u>	32.5	16.8	7.9	<u>20.6</u>	8.1	90.8	0.6	<u>5.51</u>	123	0.104	0.100	0.04
05/03/03	7:15	157	<u>1.0</u>	30.0	16.3	7.7	19.7	9.1	100.1	< 0.4	3.06	138	0.024	0.023	0.02
02/04/03	8:35	153	<u>1.1</u>	35.0	16.4	7.4	19.5	9.7	106.5	1.0	2.88	154	0.038	0.036	< 0.01
07/05/03	8:28	151	<u>1.2</u>	35.0	17.8	7.5	<u>16.0</u>	10.4	106.5	0.5	2.17	135	0.128	0.126	< 0.01
04/06/03	8:40	145	2.3	37.5	17.9	7.4	<u>14.4</u>	9.6	93.5	0.8	2.63	132	0.267	0.264	0.02
02/07/03	8:40	251	1.8	37.5	16.3	7.5	<u>12.1</u>	10.1	96.6	0.5	1.95	137	0.321	0.319	0.01
07/08/03	8:03	158	2.1	35.0	16.1	7.7	10.6	11.4	101.5	0.7	1.36	129	0.189	0.187	< 0.01
02/09/03	8:44	154	<u>1.2</u>	35.0	17.2	7.6	<u>12.3</u>	10.7	105.1	0.9	4.15	120	0.063	0.062	0.02
02/10/03	8:20	161	<u>0.9</u>	30.0	16.8	7.6	<u>13.7</u>	10.2	98.5	1.2	4.97	121	0.280	0.275	0.03
06/11/03	7:30	324	<u>1.3</u>	32.5	15.4	7.8	15.9	9.9	99.1	0.9	2.19	117	0.154	0.151	0.02
04/12/03	7:40	173	<u>0.9</u>	35.0	15.3	7.8	17.8	9.9	103.0	0.8	3.42	116	0.116	0.113	0.01

**1131-69** UD=366 m<sup>3</sup>/s (Flows from Hamilton - Bridge Street Bridge)

**Waikato River @ Horotiu Br**

08/01/03	9:30	175	<u>1.4</u>	35.0	14.6	7.8	<u>20.7</u>	9.8	110.9	1.2	<u>7.44</u>	115	0.105	0.101	0.01
04/02/03	9:00	175	<u>1.4</u>	32.5	16.1	7.5	<u>20.7</u>	8.7	97.3	0.8	<u>6.76</u>	124	0.107	0.103	< 0.01
05/03/03	8:17	176	<u>0.9</u>	32.5	16.4	7.7	19.8	9.1	99.3	0.6	3.75	140	0.027	0.026	0.01
02/04/03	9:30	168	<u>1.0</u>	32.5	16.7	7.5	19.6	10.2	112.6	1.3	3.02	147	0.060	0.058	< 0.01
07/05/03	9:42	167	<u>1.2</u>	32.5	17.6	7.5	<u>15.9</u>	10.2	105.8	0.5	2.72	138	0.154	0.152	< 0.01
04/06/03	9:30	164	2.0	35.0	17.8	7.4	<u>14.3</u>	9.7	94.4	0.9	2.69	141	0.285	0.282	< 0.01
02/07/03	9:30	284	1.7	35.0	13.3	7.2	<u>12.1</u>	10.3	95.6	0.4	2.31	98	0.351	0.348	0.01
07/08/03	9:00	212	1.8	35.0	16.2	7.7	10.6	11.2	100.4	1.5	1.71	122	0.204	0.200	< 0.01
02/09/03	9:35	204	<u>0.9</u>	32.5	16.6	7.7	<u>12.2</u>	11.1	106.1	1.4	<u>5.49</u>	123	0.099	0.095	0.03
02/10/03	9:20	262	<u>0.8</u>	30.0	16.7	7.6	13.7	10.1	98.2	1.7	4.81	117	0.298	0.294	0.02
06/11/03	8:30	309	<u>1.3</u>	32.5	15.7	7.7	15.8	9.8	98.4	0.8	2.61	118	0.185	0.182	0.02
04/12/03	8:40	211	<u>0.9</u>	32.5	15.6	7.8	18.2	10.0	105.3	0.9	3.64	116	0.109	0.106	0.01

**1131-77** UD=571 m<sup>3</sup>/s

**Waikato River @ Huntly-Tainui Br**

08/01/03	11:00	270	<u>0.9</u>	35.0	14.0	7.6	<u>20.4</u>	9.0	99.4	0.8	<u>8.10</u>	107	0.210	0.208	0.02
04/02/03	10:10	219	<u>1.1</u>	30.0	15.8	7.5	<u>21.1</u>	8.9	99.7	1.2	<u>8.26</u>	121	0.155	0.150	< 0.01
05/03/03	9:00	244	<u>0.8</u>	30.0	16.5	8.0	<u>20.0</u>	9.4	103.3	0.8	<u>5.43</u>	134	0.061	0.058	< 0.01
02/04/03	10:05	206	<u>0.9</u>	35.0	16.3	7.6	19.8	7.9	86.5	1.1	4.56	132	0.141	0.138	< 0.01
07/05/03	10:10	199	<u>1.0</u>	37.5	17.1	7.5	<u>16.0</u>	10.3	105.0	0.5	3.86	125	0.209	0.206	< 0.01
04/06/03	10:25	220	<u>1.6</u>	32.5	16.5	7.5	<u>14.1</u>	9.7	93.9	1.1	4.87	131	0.398	0.394	< 0.01
02/07/03	10:30	475	<u>0.6</u>	27.5	13.5	7.4	<u>12.4</u>	9.7	91.2	0.8	<u>14.2</u>	112	0.793	0.789	0.01
07/08/03	9:35	341	<u>1.3</u>	30.0	15.9	7.7	10.5	11.2	100.1	< 0.8	2.60	119	0.332	0.327	< 0.01
02/09/03	10:15	287	<u>0.9</u>	32.5	16.4	7.6	<u>12.5</u>	10.9	104.7	1.0	3.84	121	0.231	0.227	0.01
02/10/03	10:05	606	(0.5)	30.0	13.9	7.4	13.0	9.6	90.6	1.3	<u>17.2</u>	92	0.622	0.616	0.04
06/11/03	9:15	362	<u>0.9</u>	30.0	14.1	7.7	16.0	9.8	97.1	1.1	<u>7.89</u>	106	0.421	0.414	0.01
04/12/03	9:40	345	<u>0.6</u>	30.0	13.9	7.7	18.4	9.3	98.5	0.7	<u>6.87</u>	110	0.361	0.358	0.01

Note: < = less than value stated

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

\* New Zealand Standard Time

( ) black disk measurements taken in flows above upper decile value – don't assess for compliance



TKN g/m <sup>3</sup>	TN g/m <sup>3</sup>	DRP g/m <sup>3</sup>	TP g/m <sup>3</sup>	CL g/m <sup>3</sup>	AS g/m <sup>3</sup>	B g/m <sup>3</sup>	LI g/m <sup>3</sup>	A340F /cm	A440F /cm	ENT cfu/100ml	FC cfu/100ml	E coli cfu/100ml	CHLA g/m <sup>3</sup>	DOC g/m <sup>3</sup>	TOC g/m <sup>3</sup>
-	<0.5	-	<0.04	-	<0.01	<1.4	-	-	-	<77	-	<550	<0.02		
0.30	0.37	0.014	<u>0.041</u>	26.2	<u>0.039</u>	0.34	0.128	0.022	0.003	40	24	18	0.010	0.6	1.6
0.13	0.16	0.011	0.031	21.5	<u>0.032</u>	0.29	0.111	0.011	0.002	2	10	10	<u>0.021</u>	0.8	1.9
0.17	0.20	0.023	0.038	21.4	<u>0.030</u>	0.26	0.101	0.007	0.002	50	64	50	0.009	0.5	1.2
0.05	0.18	0.027	0.036	22.5	<u>0.031</u>	0.31	0.119	0.005	< 0.002	7	8	8	< 0.003	0.7	1.3
0.14	0.29	0.017	0.028	24.7	<u>0.031</u>	0.32	0.122	0.006	< 0.002	4	5	5	0.007	0.5	1.4
0.07	0.27	0.019	0.031	21.4	<u>0.030</u>	0.32	0.143	0.006	< 0.002	6	28	18	0.003	< 0.3	1.0
0.12	0.33	0.022	0.034	21.9	<u>0.027</u>	0.30	0.119	0.015	0.002	2	2	2	< 0.003	1.1	1.6
0.10	0.20	0.013	0.025	16.7	<u>0.023</u>	0.27	0.095	0.005	< 0.002	< 1	< 1	< 1	0.006	0.5	1.0
0.19	0.24	0.013	0.025	20.9	<u>0.025</u>	0.25	0.092	0.007	< 0.002	14	18	18	0.015	1.1	2.1
0.19	0.33	0.012	0.028	20.0	<u>0.023</u>	0.24	0.087	0.017	0.004	9	56	33	0.010	1.0	1.7
0.16	0.24	0.013	0.026	20.1	<u>0.033</u>	0.30	0.114	0.009	< 0.002	< 1	13	10	0.009	0.7	1.3
0.16	0.24	0.012	0.030	18.1	<u>0.025</u>	0.24	0.082	0.012	0.003	< 1	15	13	0.014	1.2	1.8
0.45	<u>0.53</u>	0.007	<u>0.047</u>	18.6	<u>0.029</u>	0.24	0.087	0.021	0.004	56	58	32	<u>0.029</u>	0.7	2.0
0.23	0.33	0.024	<u>0.041</u>	21.9	<u>0.032</u>	0.31	0.116	0.012	0.002	32	16	14	0.003	0.7	2.1
0.21	0.23	0.008	0.039	23.6	<u>0.029</u>	0.27	0.100	0.013	< 0.002	28	30	28	0.019	0.6	1.3
0.26	0.30	0.008	0.038	22.1	<u>0.028</u>	0.28	0.101	0.006	< 0.002	18	61	61	<u>0.024</u>	1.2	1.9
0.14	0.27	0.013	0.032	24.9	<u>0.030</u>	0.34	0.121	0.011	0.002	22	64	40	<u>0.022</u>	0.4	1.5
0.23	0.50	0.022	<u>0.043</u>	20.5	<u>0.027</u>	0.29	0.116	0.012	0.002	10	18	12	0.007	0.6	1.1
0.18	<u>0.50</u>	0.025	0.037	22.9	<u>0.026</u>	0.31	0.114	0.016	0.002	33	23	14	0.005	1.1	1.7
0.20	0.39	0.017	0.033	19.2	<u>0.020</u>	0.25	0.085	0.012	< 0.002	2	24	17	0.010	0.5	1.3
0.24	0.30	0.012	0.035	20.3	<u>0.021</u>	0.25	0.091	0.011	0.002	<b>109</b>	730	460	0.013	1.3	2.5
0.31	<u>0.59</u>	0.022	<u>0.058</u>	20.5	<u>0.021</u>	0.24	0.085	0.024	0.005	9	330	250	0.014	1.5	2.2
0.22	0.37	0.012	0.028	18.9	<u>0.028</u>	0.25	0.091	0.013	0.003	16	23	19	0.012	0.8	1.4
0.20	0.32	0.013	0.038	18.1	<u>0.028</u>	0.25	0.084	0.013	0.003	14	49	33	0.019	1.3	2.0
0.42	<u>0.53</u>	0.007	<u>0.063</u>	19.1	<u>0.028</u>	0.24	0.087	0.014	0.003	62	190	180	<u>0.031</u>	0.7	2.1
0.24	0.35	0.025	<u>0.051</u>	22.3	<u>0.032</u>	0.32	0.123	0.010	0.002	20	40	32	<u>0.027</u>	0.8	2.5
0.28	0.31	0.007	<u>0.049</u>	23.7	<u>0.030</u>	0.27	0.099	0.011	< 0.002	22	120	90	<u>0.025</u>	0.6	1.4
0.22	0.28	0.017	<u>0.048</u>	22.8	<u>0.027</u>	0.27	0.105	0.011	< 0.002	26	90	90	<u>0.036</u>	0.8	2.2
0.26	0.41	0.018	<u>0.045</u>	24.8	<u>0.029</u>	0.32	0.119	0.010	0.002	72	130	92	0.017	0.4	1.7
0.19	0.48	0.026	<u>0.053</u>	20.7	<u>0.027</u>	0.30	0.123	0.010	0.002	31	38	30	0.007	0.4	1.2
0.17	<u>0.52</u>	0.034	<u>0.051</u>	22.9	<u>0.026</u>	0.30	0.114	0.017	0.007	58	66	43	0.005	1.2	1.8
0.12	0.32	0.021	<u>0.041</u>	19.8	<u>0.021</u>	0.25	0.086	0.009	< 0.002	6	17	13	0.007	0.6	1.3
0.26	0.36	0.039	<u>0.057</u>	19.4	<u>0.020</u>	0.24	0.088	0.011	0.002	<b>198</b>	180	160	0.013	3.8	4.2
0.31	<u>0.61</u>	0.025	<u>0.064</u>	20.3	<u>0.021</u>	0.23	0.083	0.027	0.005	16	360	220	0.015	1.9	2.5
0.24	0.43	0.017	<u>0.042</u>	18.6	<u>0.027</u>	0.25	0.090	0.013	0.003	15	58	29	0.014	0.8	1.3
0.23	0.34	0.015	<u>0.052</u>	18.5	<u>0.027</u>	0.27	0.084	0.014	0.003	18	77	60	<u>0.025</u>	1.2	2.0
0.28	0.49	0.010	<u>0.069</u>	18.1	<u>0.021</u>	0.18	0.067	0.019	0.003	36	320	220	<u>0.022</u>	0.9	1.8
0.26	0.42	0.030	<u>0.065</u>	21.7	<u>0.027</u>	0.28	0.106	0.013	0.002	8	310	250	0.008	0.9	2.6
0.30	0.36	0.008	<u>0.073</u>	23.2	<u>0.027</u>	0.24	0.087	0.015	0.002	36	90	80	<u>0.030</u>	0.8	1.6
0.24	0.38	0.022	<u>0.073</u>	21.9	<u>0.022</u>	0.24	0.086	0.016	0.002	26	640	<b>640</b>	<u>0.033</u>	0.8	2.4
0.27	0.48	0.028	<u>0.063</u>	23.9	<u>0.026</u>	0.29	0.104	0.012	0.003	20	98	74	<u>0.023</u>	0.6	2.0
0.25	<u>0.65</u>	0.051	<u>0.075</u>	18.9	<u>0.020</u>	0.24	0.098	0.015	0.003	25	70	43	< 0.003	0.6	1.7
0.33	<u>1.12</u>	0.025	<u>0.089</u>	16.7	<u>0.012</u>	0.15	0.057	0.033	0.006	<b>250</b>	340	260	0.004	2.0	2.9
0.23	<u>0.56</u>	0.023	<u>0.054</u>	18.9	<u>0.018</u>	0.22	0.074	0.011	0.002	15	31	21	0.008	0.8	1.5
0.31	<u>0.54</u>	0.026	<u>0.052</u>	20.2	<u>0.017</u>	0.20	0.073	0.015	0.003	<b>85</b>	60	50	0.016	1.3	2.6
0.42	<u>1.04</u>	0.023	<u>0.098</u>	15.7	0.009	0.11	0.038	0.038	0.007	15	1000	<b>900</b>	0.009	2.2	4.0
0.30	<u>0.72</u>	0.023	<u>0.073</u>	16.3	<u>0.016</u>	0.16	0.056	0.025	0.005	25	280	170	0.011	1.3	2.0
0.27	<u>0.63</u>	0.020	<u>0.081</u>	16.0	<u>0.017</u>	0.17	0.053	0.021	0.004	25	300	300	0.016	1.5	2.4

Note: < = less than value stated

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

\* New Zealand Standard Time

() black disk measurements taken in flows above upper decile value – don't assess for compliance

DATE	TIME*	FLOW	BDISK	COLOR	COND	PH	TEMP	DO	PCDO	BOD5	TURB	TDS	NNN	NO3-N	NH4-N
dd/mm/yy	HH:MM	m <sup>3</sup> /s	m	units	mS/m	units	'C	g/m <sup>3</sup>	%Sat	g/m <sup>3</sup>	NTU	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>	g/m <sup>3</sup>
Satisfactory Water			>1.6	-	-	6.5-9	<12 (May-Sep)	>80	-	<5	-	-	-	-	<0.88
Quality Guideline/Standard							<20 (Oct-Apr)								

1131-91 UD=640 m<sup>3</sup>/s**Waikato River @ Mercer Br**

08/01/03	12:00	258	-	-	14.6	7.8	<u>21.1</u>	10.1	111.2	1.1	<u>9.64</u>	109	0.172	0.170	< 0.01
04/02/03	11:12	222	-	-	15.8	7.7	<u>22.0</u>	9.5	108.8	2.5	<u>14.1</u>	117	0.030	0.028	< 0.01
05/03/03	9:50	249	-	-	16.1	8.0	<u>20.8</u>	9.9	109.9	1.3	<u>10.1</u>	134	< 0.002	< 0.002	< 0.01
02/04/03	11:05	209	-	-	16.6	7.8	<u>21.1</u>	9.7	108.6	1.3	<u>6.42</u>	143	0.065	0.062	< 0.01
07/05/03	11:20	180	-	-	17.1	7.6	<u>17.2</u>	9.9	103.5	0.6	<u>6.89</u>	134	0.165	0.163	< 0.01
04/06/03	11:15	208	-	-	17.4	7.5	<u>15.3</u>	9.6	95.2	1.2	<u>6.78</u>	130	0.370	0.367	< 0.01
02/07/03	11:15	492	-	-	14.8	7.3	<u>12.8</u>	9.7	91.8	1.0	<u>14.2</u>	121	0.776	0.772	< 0.01
07/08/03	10:26	371	-	-	16.2	7.6	11.2	11.1	100.4	0.9	4.34	132	0.392	0.389	< 0.01
02/09/03	10:55	282	-	-	16.9	7.5	<u>13.3</u>	9.9	96.0	1.7	<u>8.30</u>	123	0.253	0.252	0.01
02/10/03	10:55	670	-	-	15.3	7.2	13.6	8.6	82.8	1.7	<u>16.6</u>	116	0.568	0.561	0.03
06/11/03	9:55	414	-	-	15.0	7.7	16.9	9.2	95.8	1.4	<u>9.62</u>	115	0.331	0.326	0.02
04/12/03	10:35	378	-	-	14.8	7.7	19.5	9.2	99.5	1.0	<u>14.4</u>	115	0.310	0.307	0.01

1131-133

**Waikato River @ Tuakau Br**

08/01/03	12:30	-	<u>0.6</u>	30.0	14.5	7.7	<u>22.0</u>	10.7	123.7	1.5	<u>18.0</u>	113	0.123	0.120	< 0.01
04/02/03	11:45	-	<u>0.8</u>	30.0	15.8	7.8	<u>23.0</u>	10.3	119.8	2.3	<u>8.91</u>	119	0.002	< 0.002	< 0.01
05/03/03	10:30	-	<u>0.5</u>	30.0	16.1	8.1	<u>21.4</u>	10.4	115.8	1.5	<u>10.6</u>	131	< 0.002	< 0.002	< 0.01
02/04/03	11:30	-	<u>0.6</u>	35.0	16.5	7.8	<u>21.4</u>	10.7	120.5	2.0	<u>6.99</u>	142	0.006	0.005	< 0.01
07/05/03	11:50	-	<u>0.8</u>	30.0	17.2	7.6	<u>17.5</u>	10.4	107.2	< 0.4	<u>5.45</u>	133	0.162	0.159	< 0.01
04/06/03	11:45	-	<u>1.2</u>	30.0	17.2	7.4	<u>15.3</u>	9.4	93.1	1.0	<u>5.95</u>	129	0.376	0.373	0.01
02/07/03	11:45	-	<u>0.5</u>	27.5	14.6	7.3	<u>12.7</u>	9.2	86.7	0.8	<u>12.1</u>	123	0.719	0.714	0.01
07/08/03	10:57	-	<u>1.0</u>	27.5	16.2	7.5	11.4	10.7	97.6	1.0	<u>5.88</u>	121	0.344	0.341	< 0.01
02/09/03	11:20	-	<u>0.7</u>	30.0	16.8	7.6	<u>13.5</u>	9.9	97.8	1.3	<u>8.08</u>	129	0.266	0.265	0.01
02/10/03	11:30	-	<u>0.5</u>	27.5	15.3	7.2	13.8	8.7	84.6	1.7	<u>21.7</u>	108	0.586	0.579	0.02
06/11/03	10:35	-	<u>0.6</u>	27.5	14.9	7.7	17.5	9.5	99.0	1.4	<u>9.24</u>	118	0.300	0.298	< 0.01
04/12/03	11:05	-	<u>0.4</u>	27.5	14.4	7.8	19.8	9.2	99.5	1.0	<u>9.44</u>	112	0.280	0.278	0.01

Note: &lt; = less than value stated

\* New Zealand Standard Time

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1  
 () black disk measurements taken in flows above upper decile value – don't assess for compliance

TKN g/m <sup>3</sup>	TN g/m <sup>3</sup>	DRP g/m <sup>3</sup>	TP g/m <sup>3</sup>	CL g/m <sup>3</sup>	AS g/m <sup>3</sup>	B g/m <sup>3</sup>	LI g/m <sup>3</sup>	A340F /cm	A440F /cm	ENT cfu/100ml	FC	E coli	CHLA g/m <sup>3</sup>	DOC g/m <sup>3</sup>	TOC g/m <sup>3</sup>
-	<0.5	-	<0.04	-	<0.01	<1.4	-	-	-	<77	-	<550	<0.02		
0.40	<u>0.57</u>	0.011	<u>0.114</u>	18.6	<u>0.020</u>	0.20	0.066	0.023	0.004	28	120	120	<u>0.028</u>	1.2	2.3
0.42	0.45	0.014	<u>0.069</u>	21.4	<u>0.027</u>	0.28	0.104	0.014	0.003	4	34	34	0.019	0.9	2.7
0.47	0.47	0.006	<u>0.083</u>	23.2	<u>0.026</u>	0.23	0.083	0.018	0.003	10	120	70	<u>0.047</u>	0.9	3.5
0.30	0.37	0.012	<u>0.075</u>	22.0	<u>0.022</u>	0.25	0.092	0.015	0.003	11	56	56	<u>0.047</u>	0.9	2.8
0.35	<u>0.52</u>	0.018	<u>0.065</u>	24.0	<u>0.024</u>	0.29	0.099	0.015	0.002	10	52	52	<u>0.030</u>	0.8	2.4
0.21	<u>0.58</u>	0.035	<u>0.078</u>	19.5	<u>0.021</u>	0.26	0.099	0.014	0.003	10	68	62	0.005	0.8	1.9
0.31	<u>1.09</u>	0.032	<u>0.101</u>	18.6	<u>0.014</u>	0.17	0.065	0.032	0.011	<u>350</u>	460	320	0.003	2.0	3.2
0.27	<u>0.66</u>	0.019	<u>0.062</u>	19.6	<u>0.016</u>	0.21	0.070	0.017	0.003	5	45	26	0.011	1.1	2.0
0.32	<u>0.57</u>	0.017	<u>0.071</u>	20.9	<u>0.013</u>	0.19	0.064	0.030	0.006	40	240	170	0.019	2.3	4.9
0.50	<u>1.07</u>	0.021	<u>0.121</u>	18.3	<u>0.011</u>	0.14	0.045	0.060	0.011	20	1400	<u>1300</u>	0.019	4.2	5.0
0.41	<u>0.74</u>	0.018	<u>0.083</u>	18.1	<u>0.019</u>	0.19	0.067	0.029	0.006	15	100	90	0.019	1.7	2.3
0.35	<u>0.66</u>	0.015	<u>0.101</u>	16.8	<u>0.017</u>	0.18	0.054	0.028	0.005	12	200	200	0.019	1.9	4.4
0.50	<u>0.62</u>	0.010	<u>0.114</u>	19.1	<u>0.021</u>	0.19	0.063	0.028	0.005	24	190	150	<u>0.042</u>	1.2	3.7
0.39	0.39	0.013	<u>0.067</u>	22.0	<u>0.027</u>	0.28	0.108	0.018	0.006	8	26	24	<u>0.053</u>	1.1	2.7
0.47	0.47	0.007	<u>0.093</u>	23.5	<u>0.027</u>	0.23	0.082	0.019	0.004	18	80	80	<u>0.041</u>	1.1	3.7
0.30	0.31	0.006	<u>0.081</u>	22.0	<u>0.022</u>	0.24	0.086	0.019	0.005	7	55	55	<u>0.064</u>	1.2	3.3
0.27	0.43	0.020	<u>0.067</u>	24.1	<u>0.024</u>	0.30	0.100	0.014	0.002	8	50	34	<u>0.032</u>	0.7	2.4
0.27	<u>0.65</u>	0.034	<u>0.080</u>	19.5	<u>0.019</u>	0.25	0.097	0.017	0.004	11	53	42	0.016	0.7	1.8
0.39	<u>1.11</u>	0.027	<u>0.083</u>	19.3	<u>0.014</u>	0.17	0.063	0.037	0.010	<u>340</u>	540	340	0.006	2.5	3.5
0.26	<u>0.60</u>	0.018	<u>0.061</u>	20.7	<u>0.016</u>	0.21	0.069	0.021	0.003	4	22	19	0.013	1.3	2.3
0.32	<u>0.59</u>	0.020	<u>0.069</u>	20.8	<u>0.014</u>	0.20	0.065	0.026	0.005	45	180	100	<u>0.022</u>	1.9	3.7
0.51	<u>1.10</u>	0.018	<u>0.114</u>	17.5	0.010	0.12	0.041	0.057	0.010	26	400	400	0.012	3.5	5.5
0.34	<u>0.64</u>	0.015	<u>0.077</u>	17.8	<u>0.018</u>	0.19	0.068	0.025	0.005	22	110	110	0.018	1.4	2.3
0.42	<u>0.70</u>	0.012	<u>0.093</u>	16.8	<u>0.015</u>	0.18	0.052	0.032	0.006	11	93	51	<u>0.030</u>	1.9	4.5

Note: < = less than value stated

Underlined values don't comply with the "satisfactory" water quality Guidelines and Standards – Table 1

\* New Zealand Standard Time

() black disk measurements taken in flows above upper decile value – don't assess for compliance

## References

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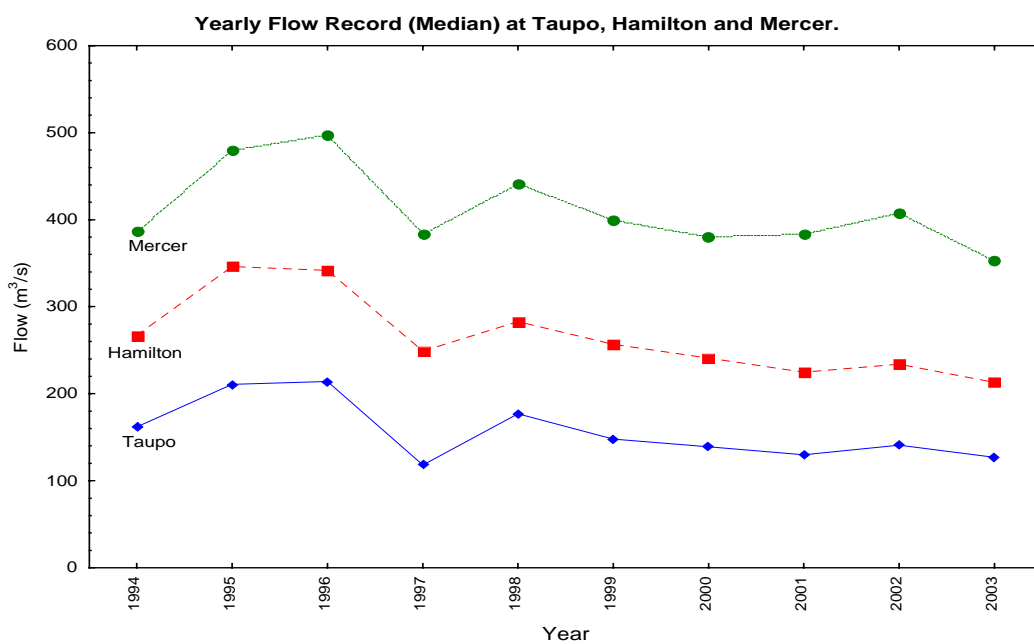
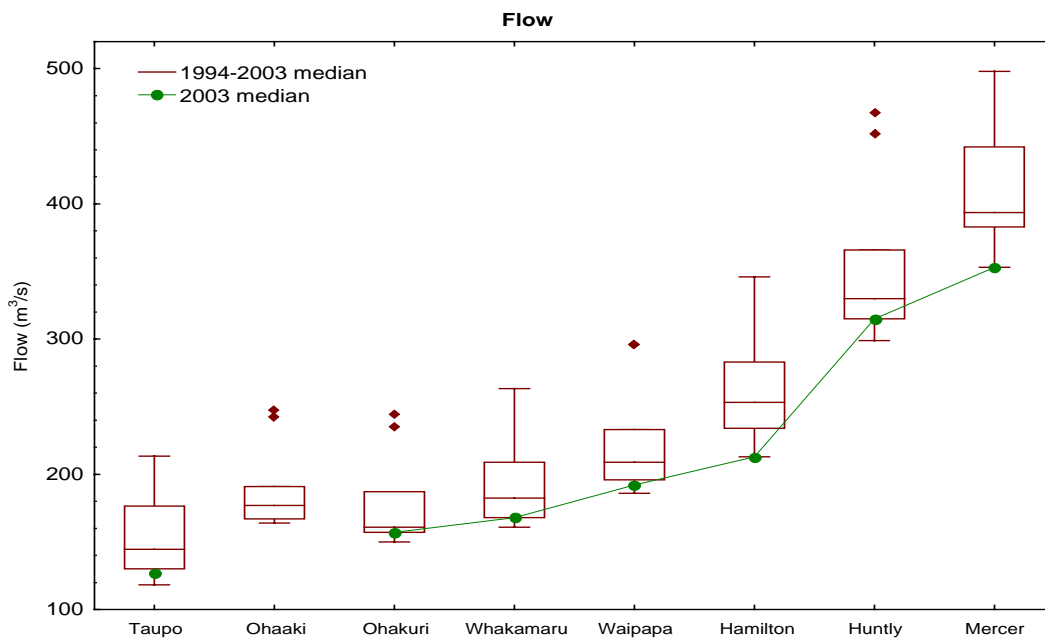
# Appendix I

## Flow Information

Median Flows of the Waikato River and Main Tributaries

Location	DISTANCE		FLOW RATE* (m <sup>3</sup> /s)										10 YEAR Median
	km		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
Taupo	4.2		162	211	214	118	177	148	139	130	141	127	158
Ohakuri	75.8		174	236	244	153	187	157	158	150	164	157	174
Whakamaru	105.0		209	263	263	182	204	174	168	161	183	168	197
Waipapa	126.1		233	297	297	207	232	205	196	186	211	192	222
Hamilton	211.5		267	346	342	249	283	257	241	225	234	213	259
Huntly	246.5		366	452	467	332	364	327	314	299	328	315	354
Mercer	286.3		387	480	498	383	442	400	381	383	408	353	409
Waiotapu Stm	46.6		3.0	4.0	3.7	3.8	3.5	3.4	2.8	3.2	2.8	2.6	3.3
Waipa River	232.7		77	76	95	58	66	55	52	62	73	61	64

\*Rating curve errors mean estimates of flow are ± 8%

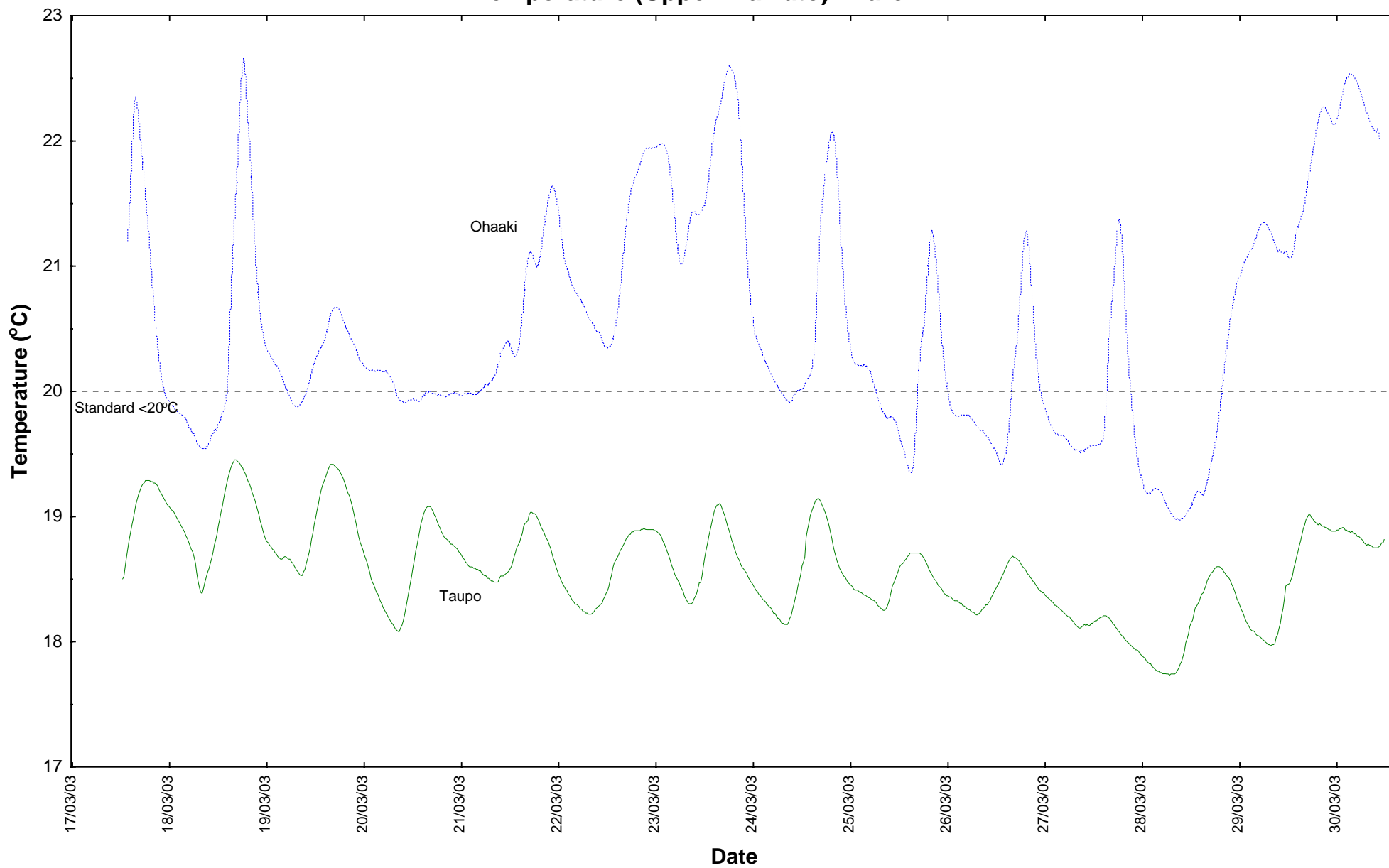


# Appendix II

## Datasonde Deployments

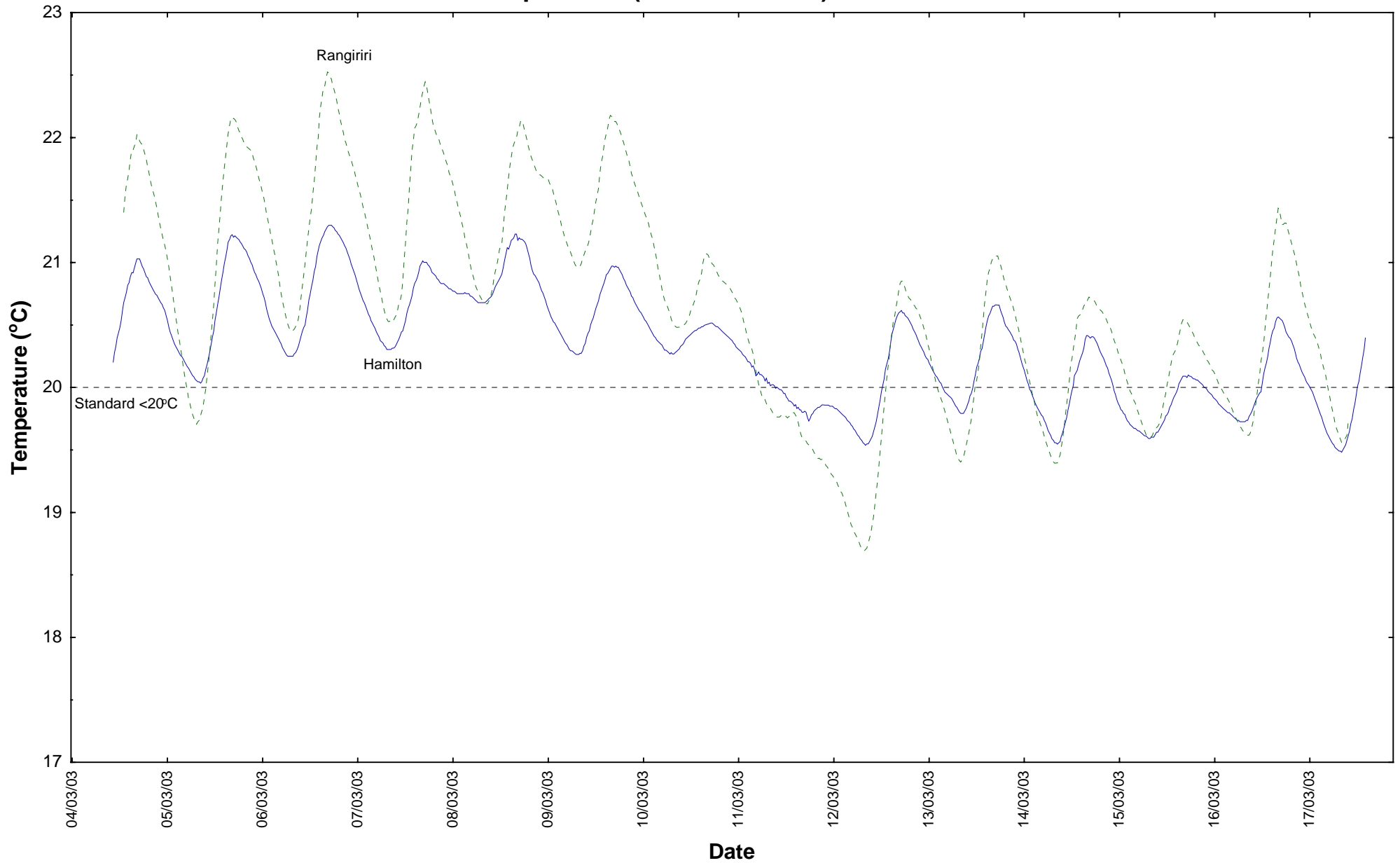
### Diurnal variation of Some Water Quality Parameters

### Temperature (Upper Waikato): March

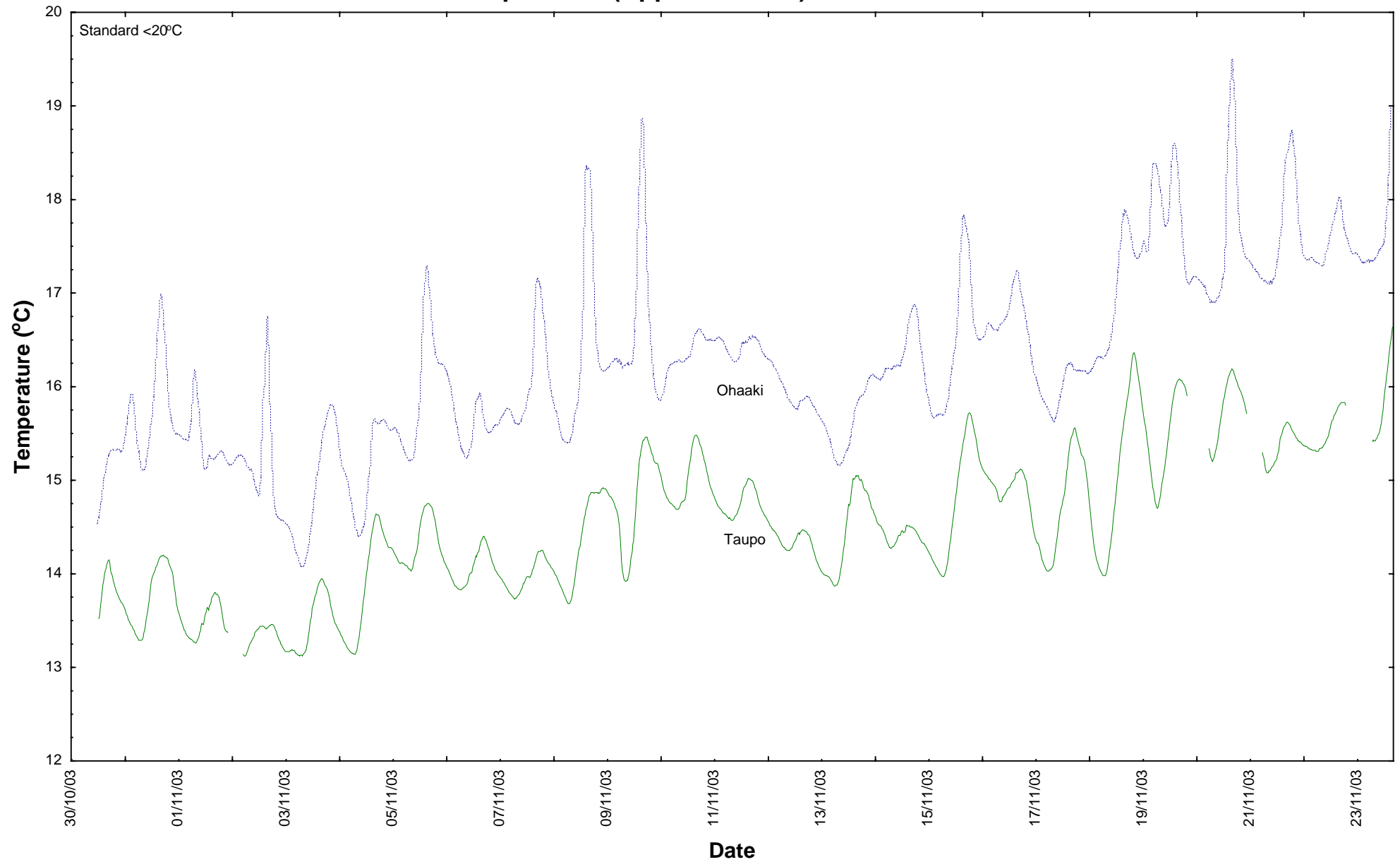




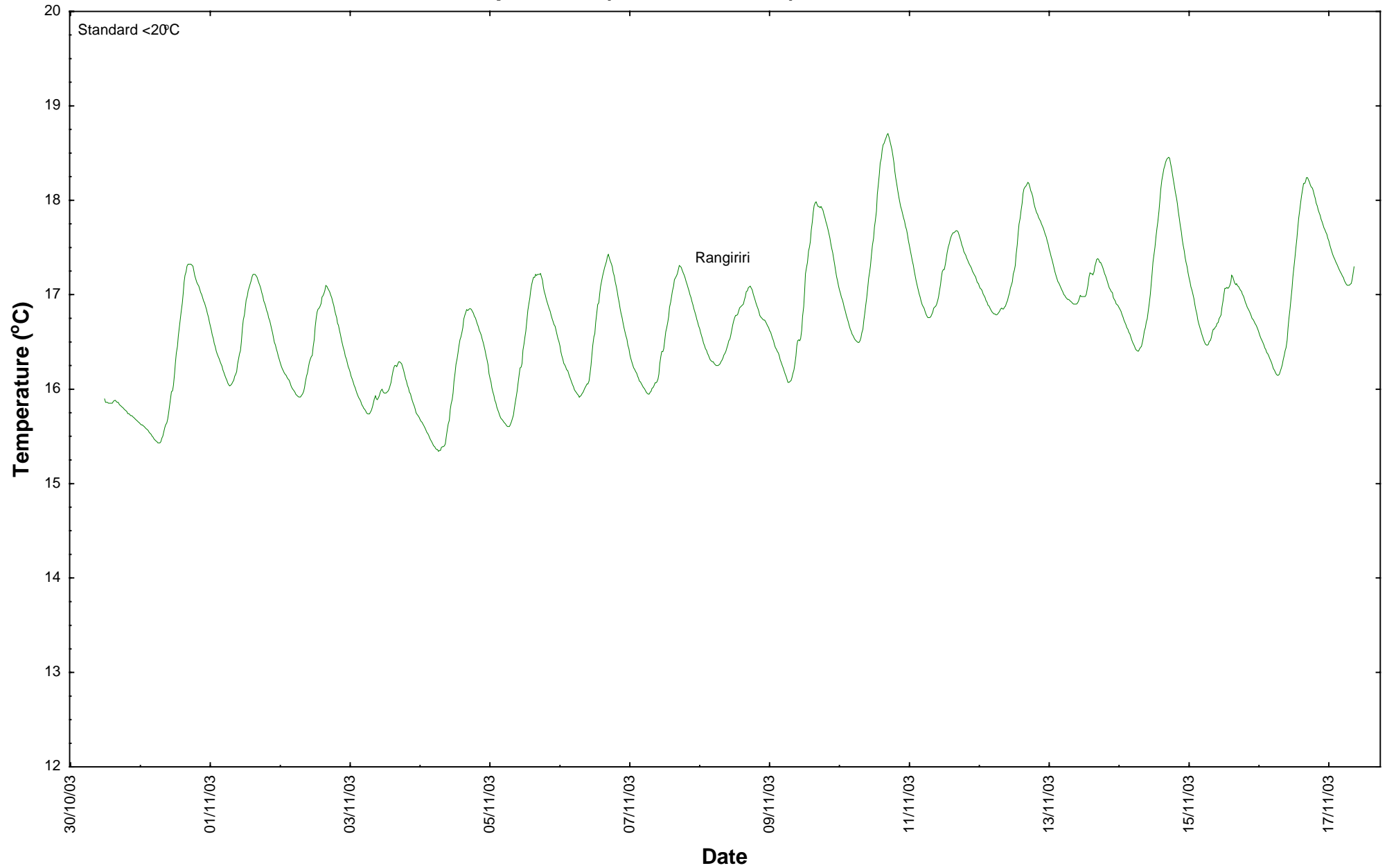
### Temperature (Lower Waikato): March



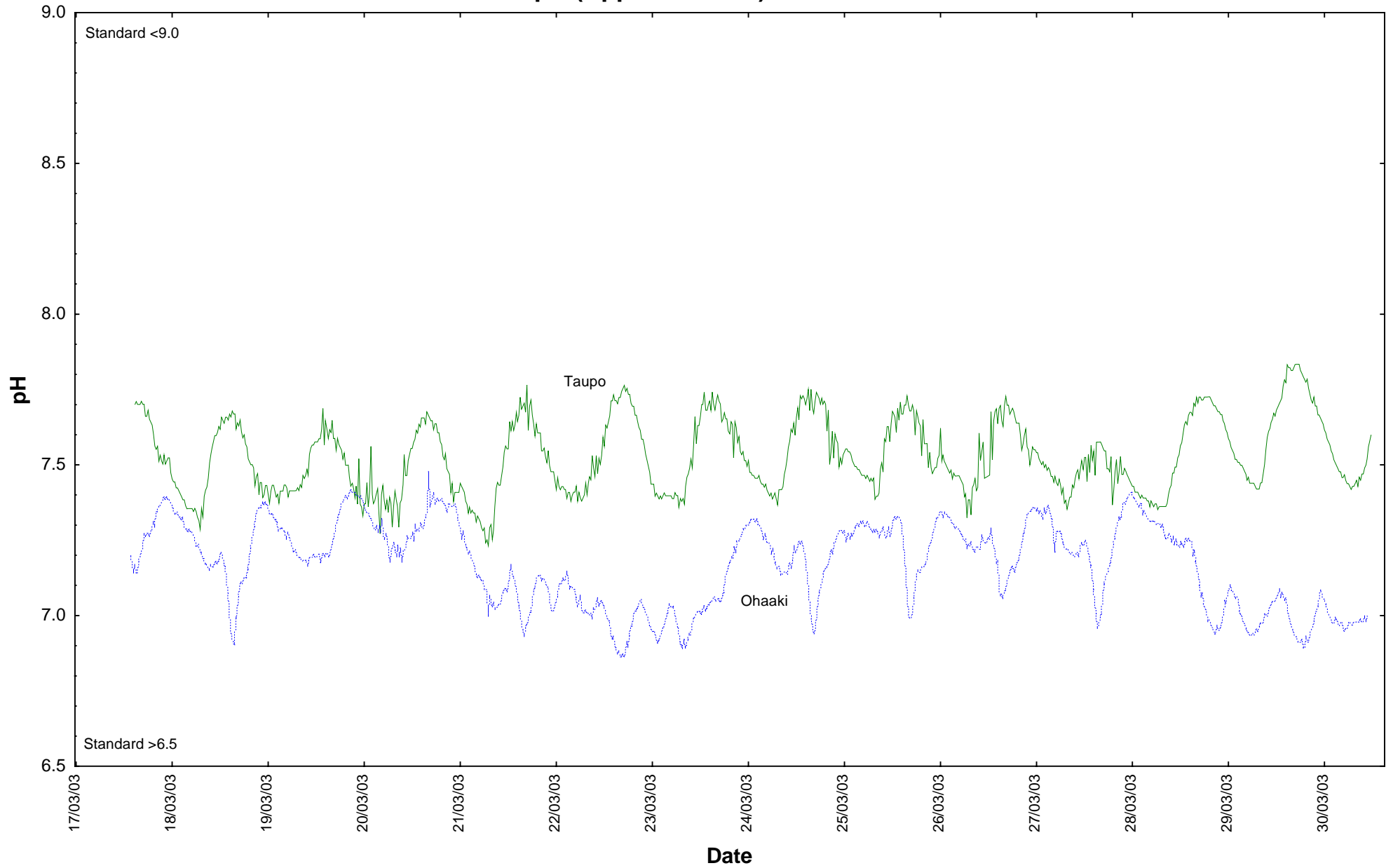
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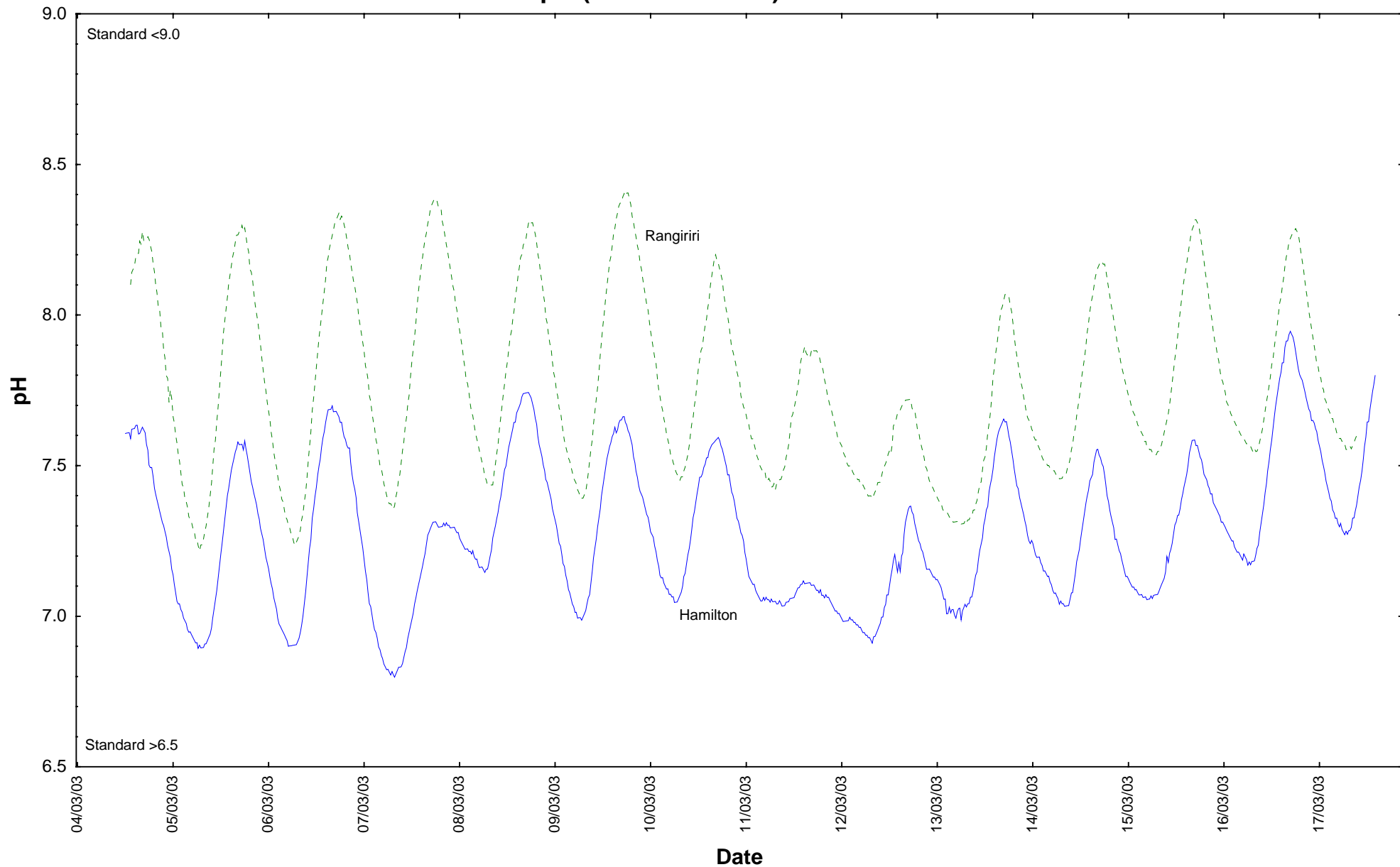
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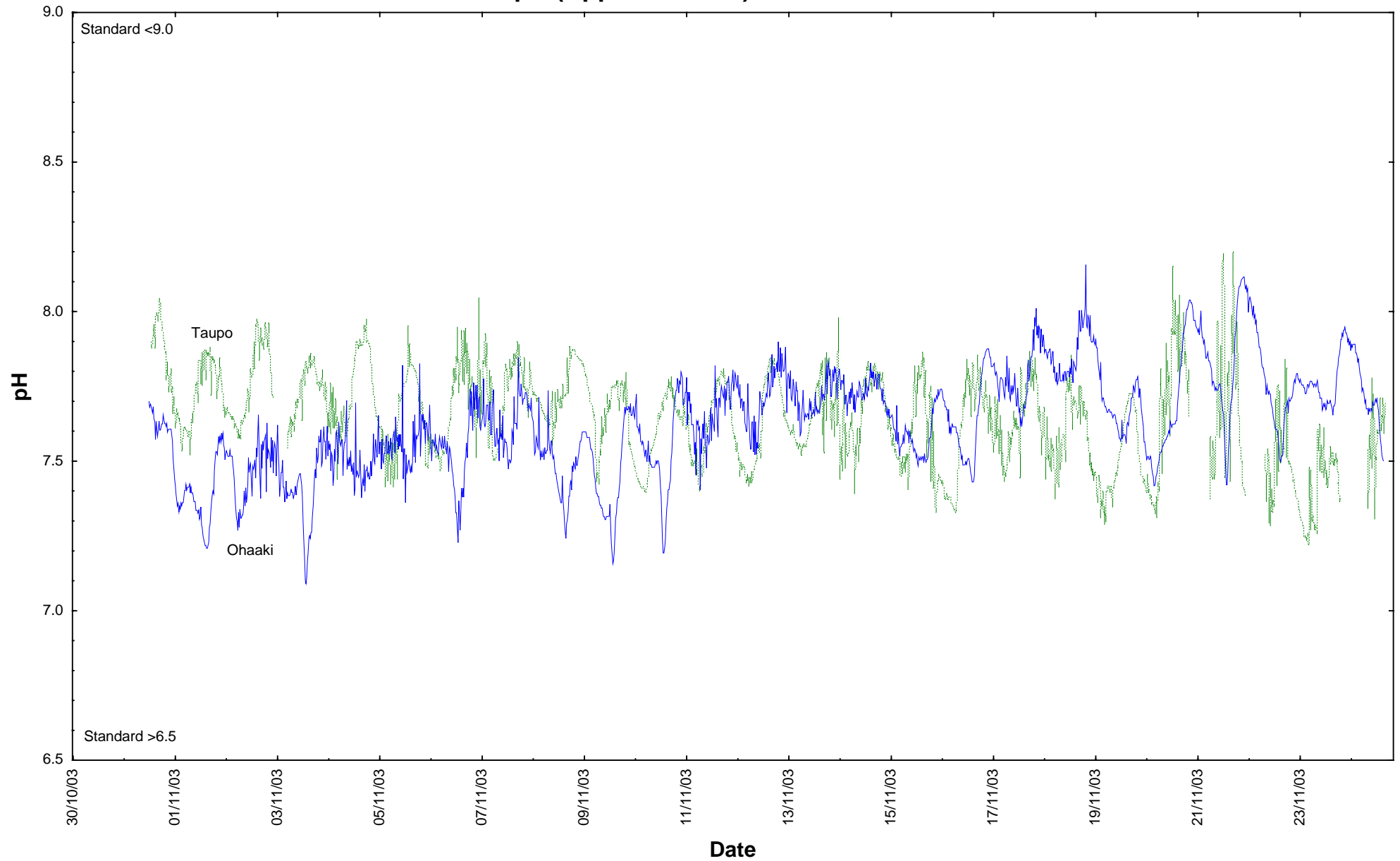
### pH (Upper Waikato): March



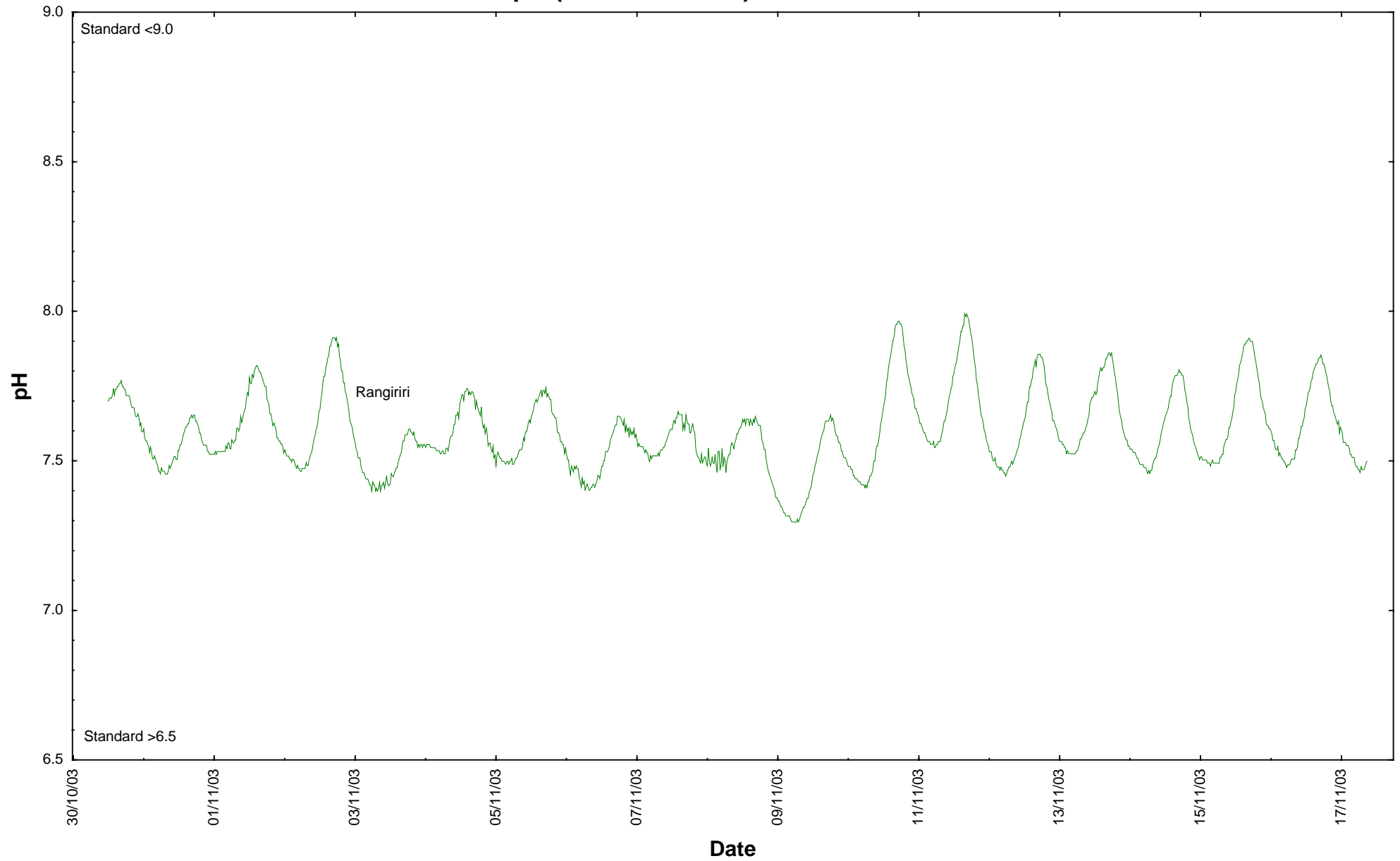
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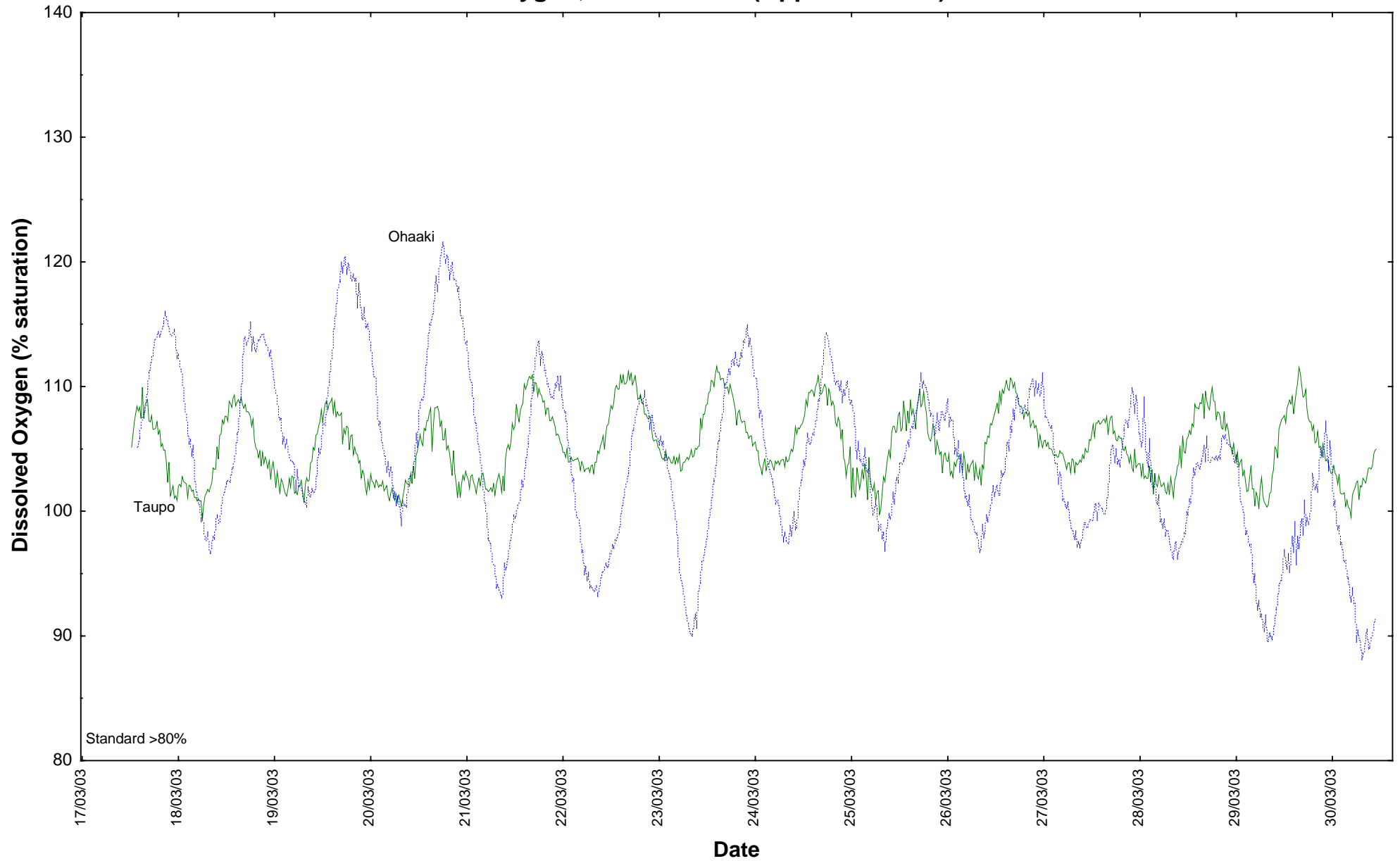
### pH (Upper Waikato): November



### pH (Lower Waikato): November

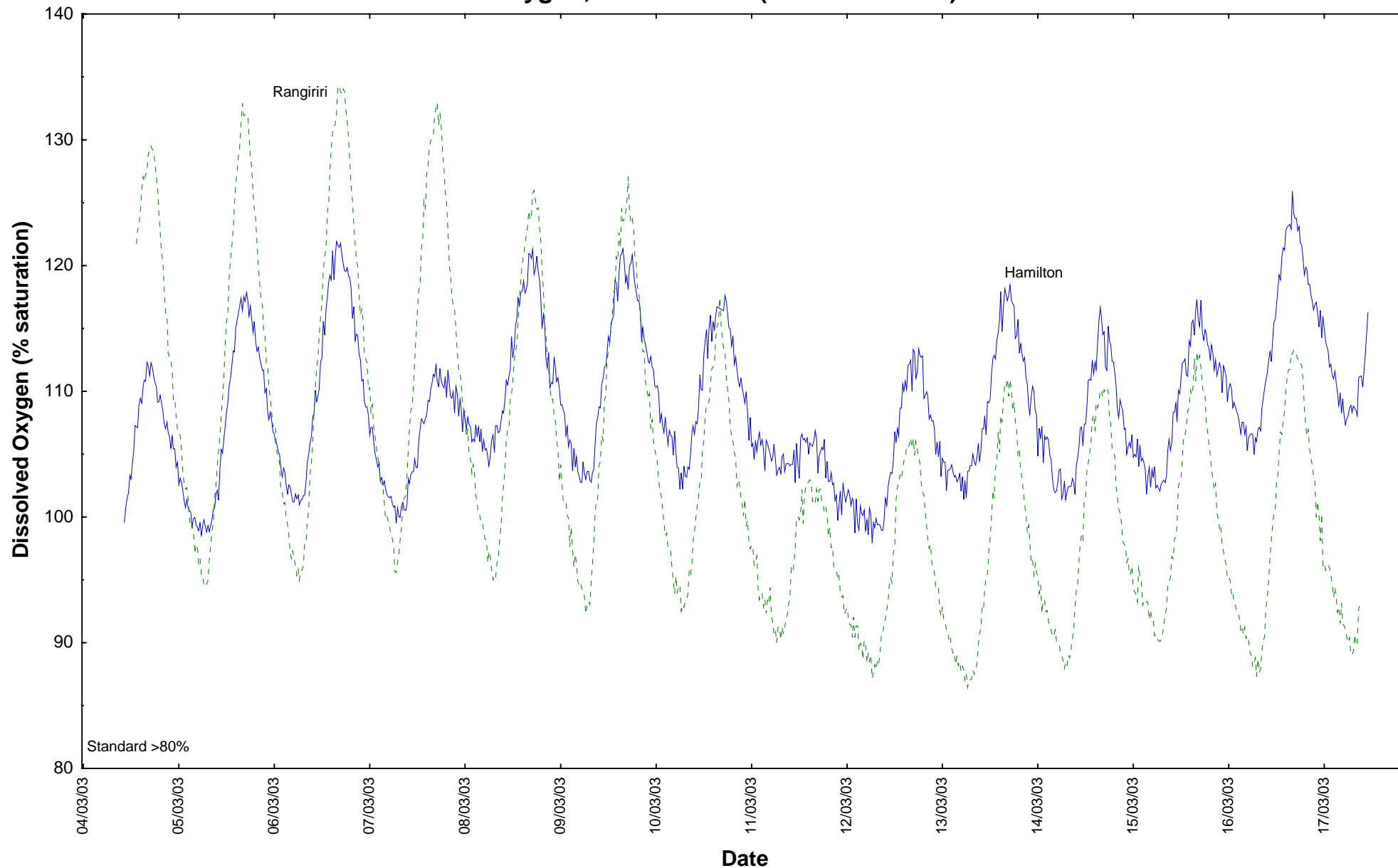


### Dissolved Oxygen, % saturation (Upper Waikato): March

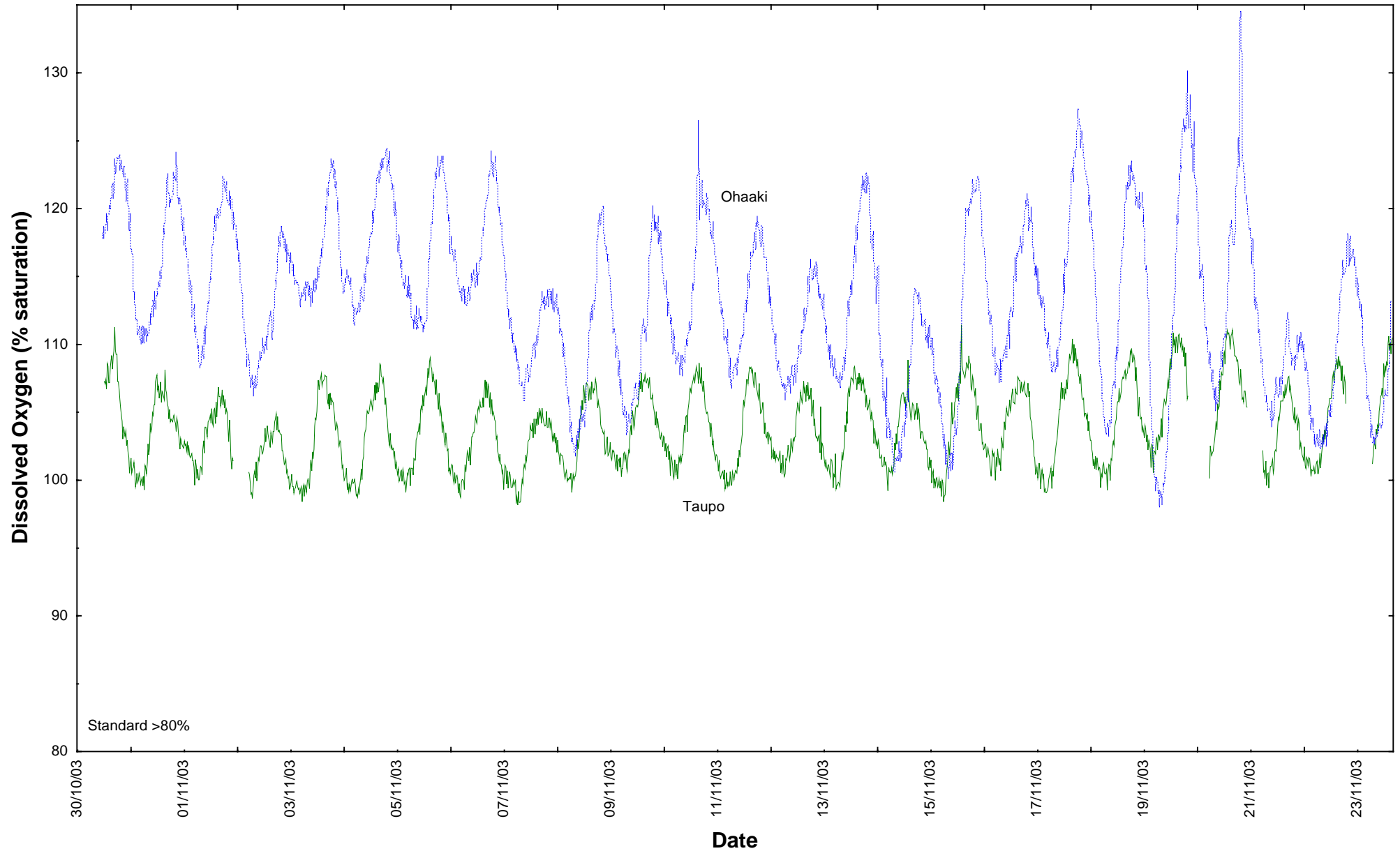




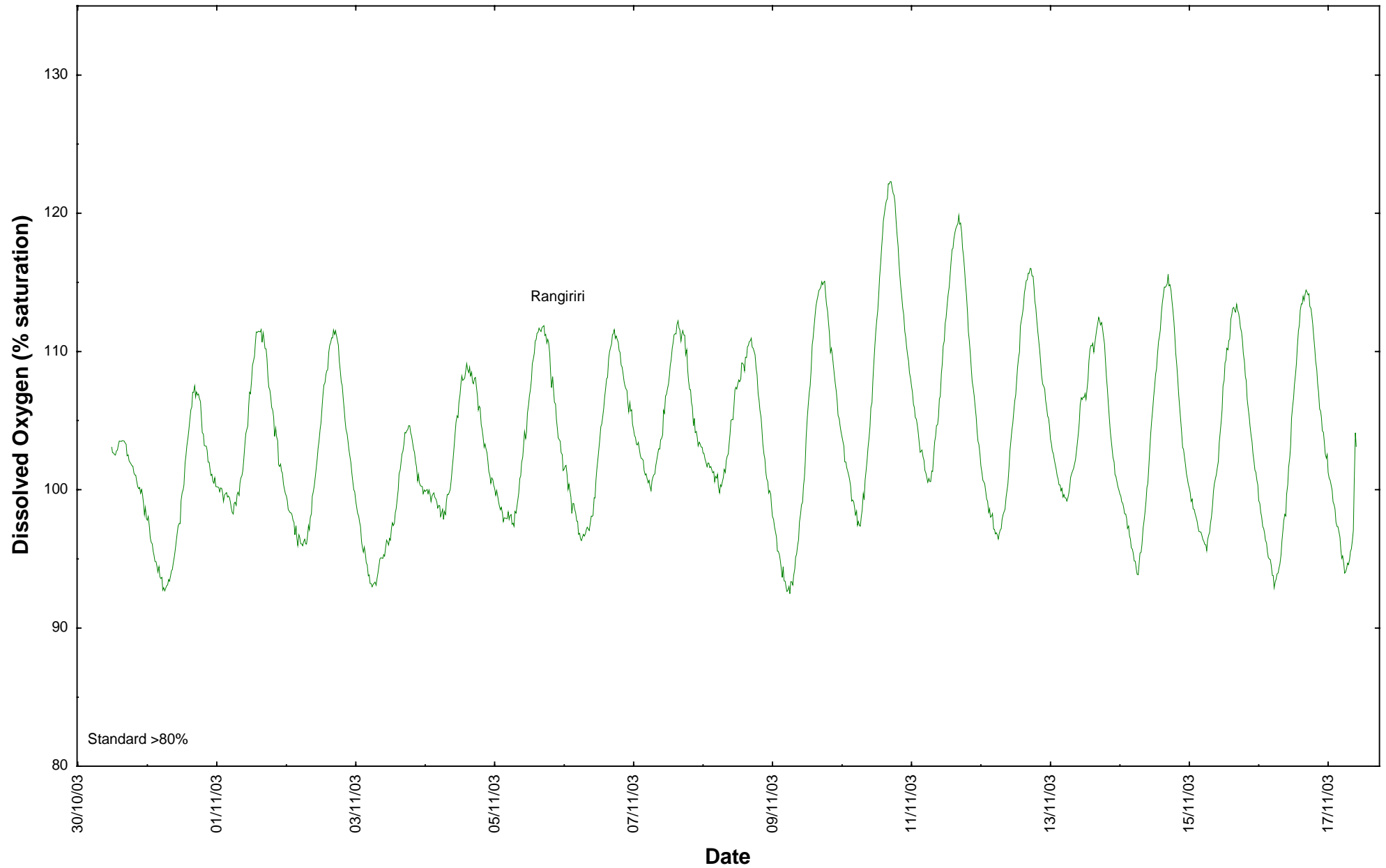
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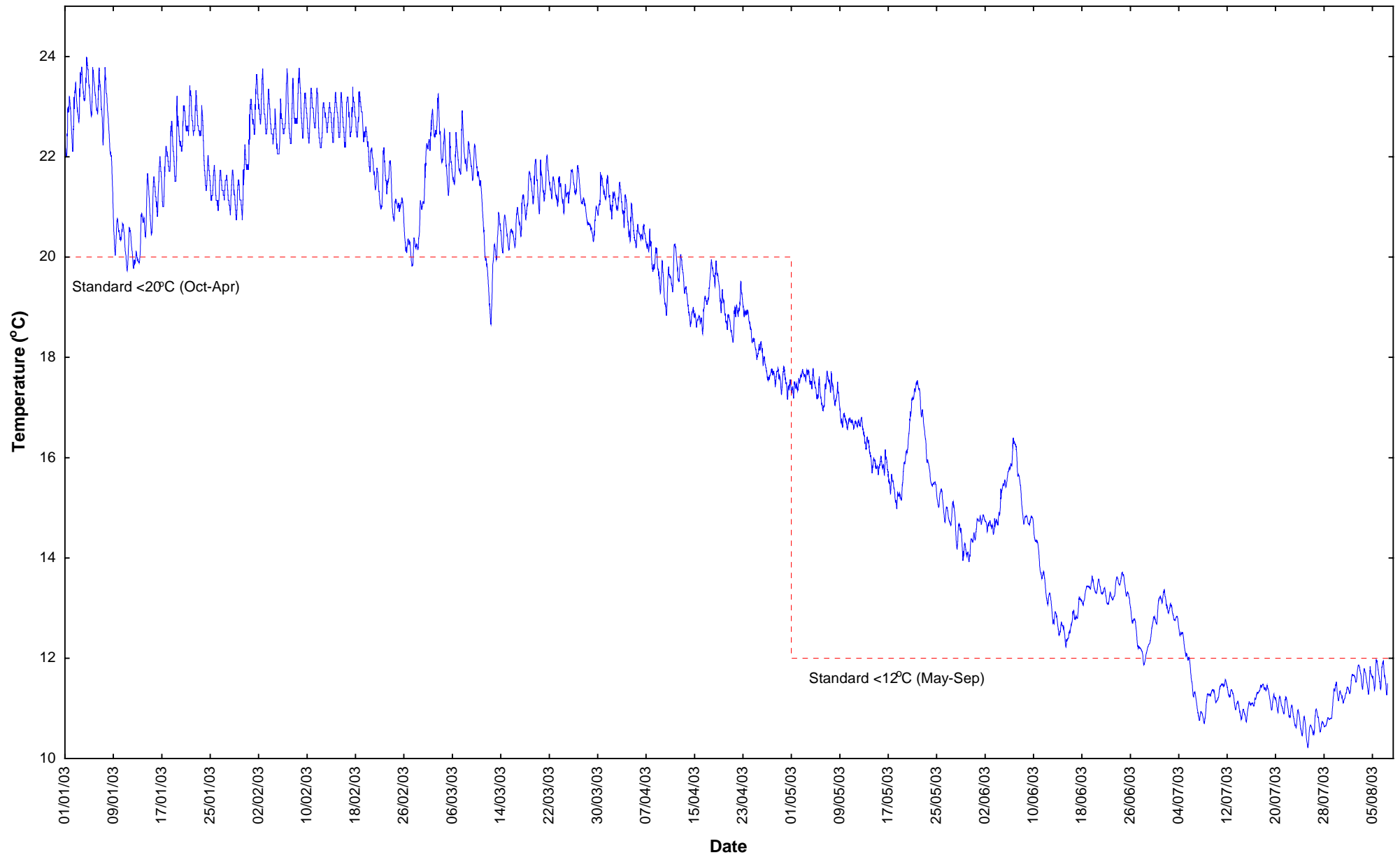
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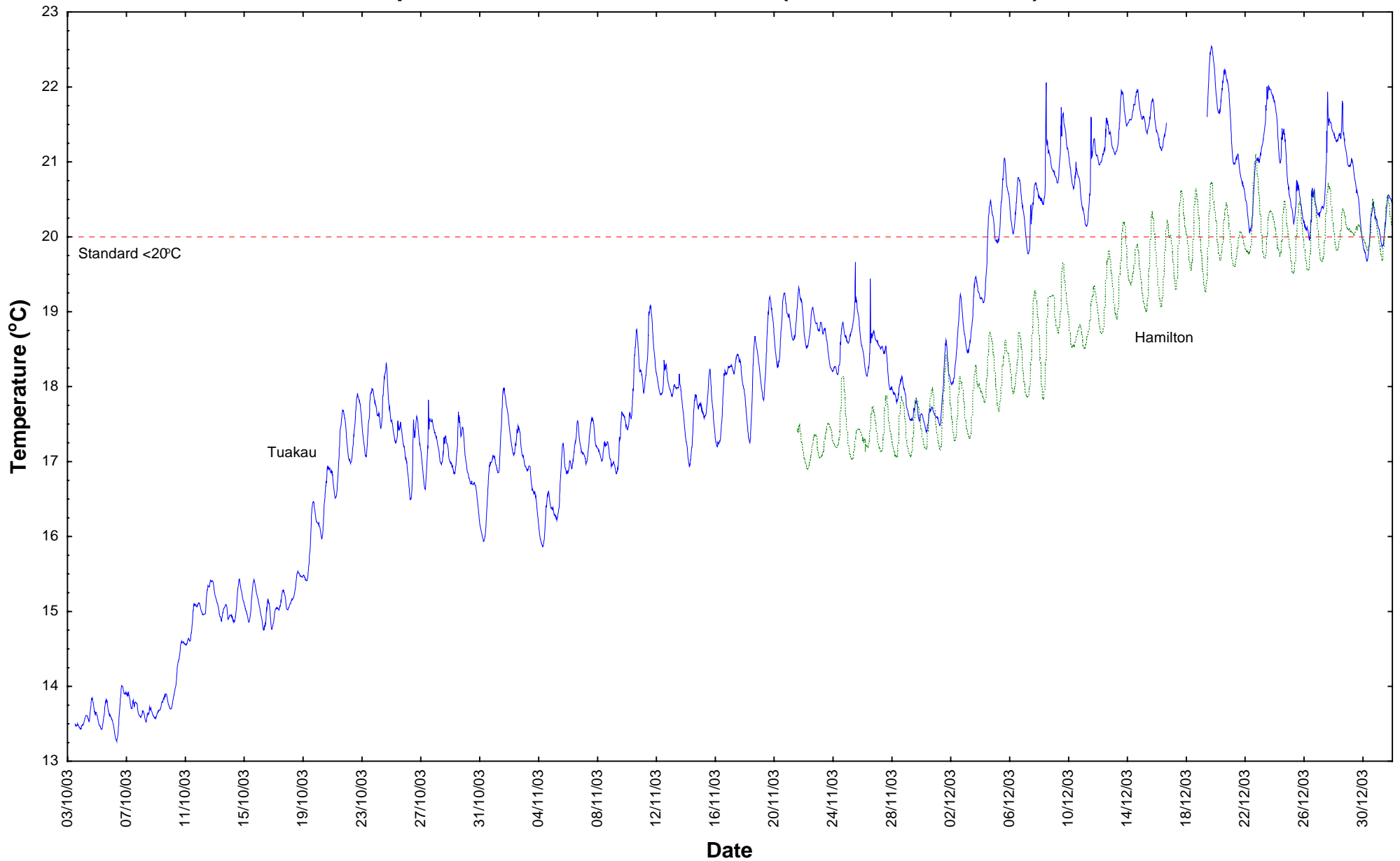
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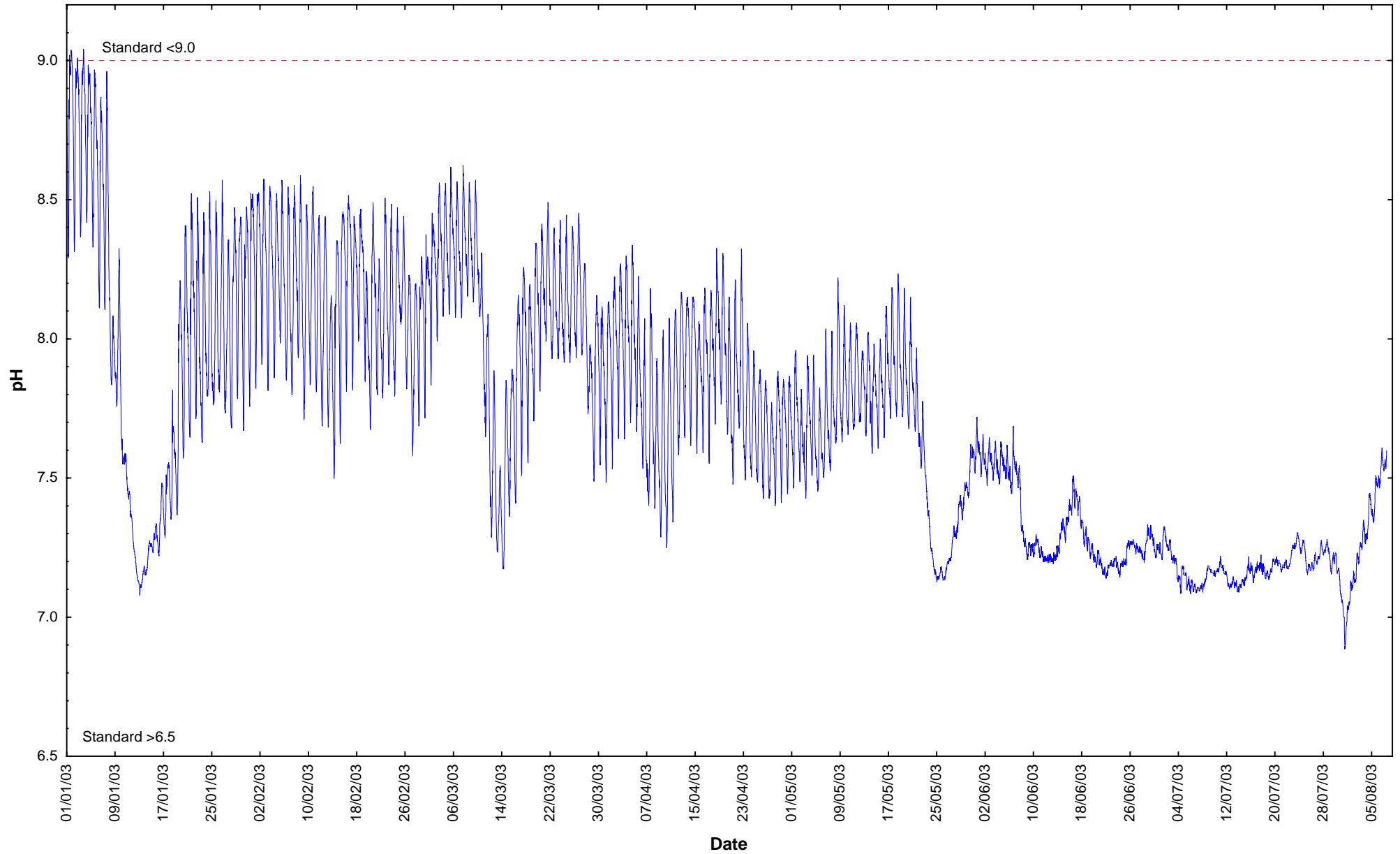
### Temperature: Tuakau (January - August)



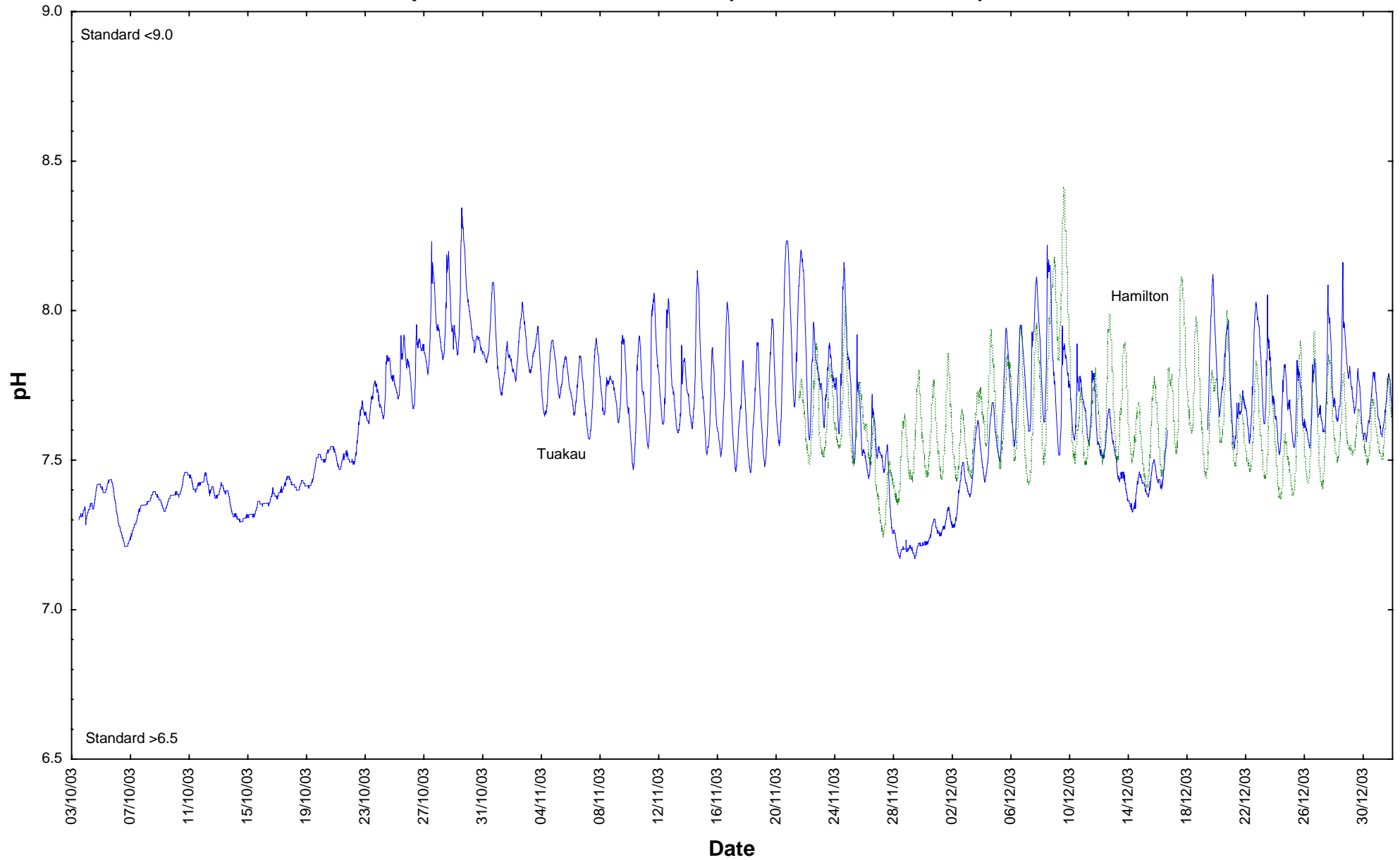
### Temperature: Tuakau and Hamilton (October - December)



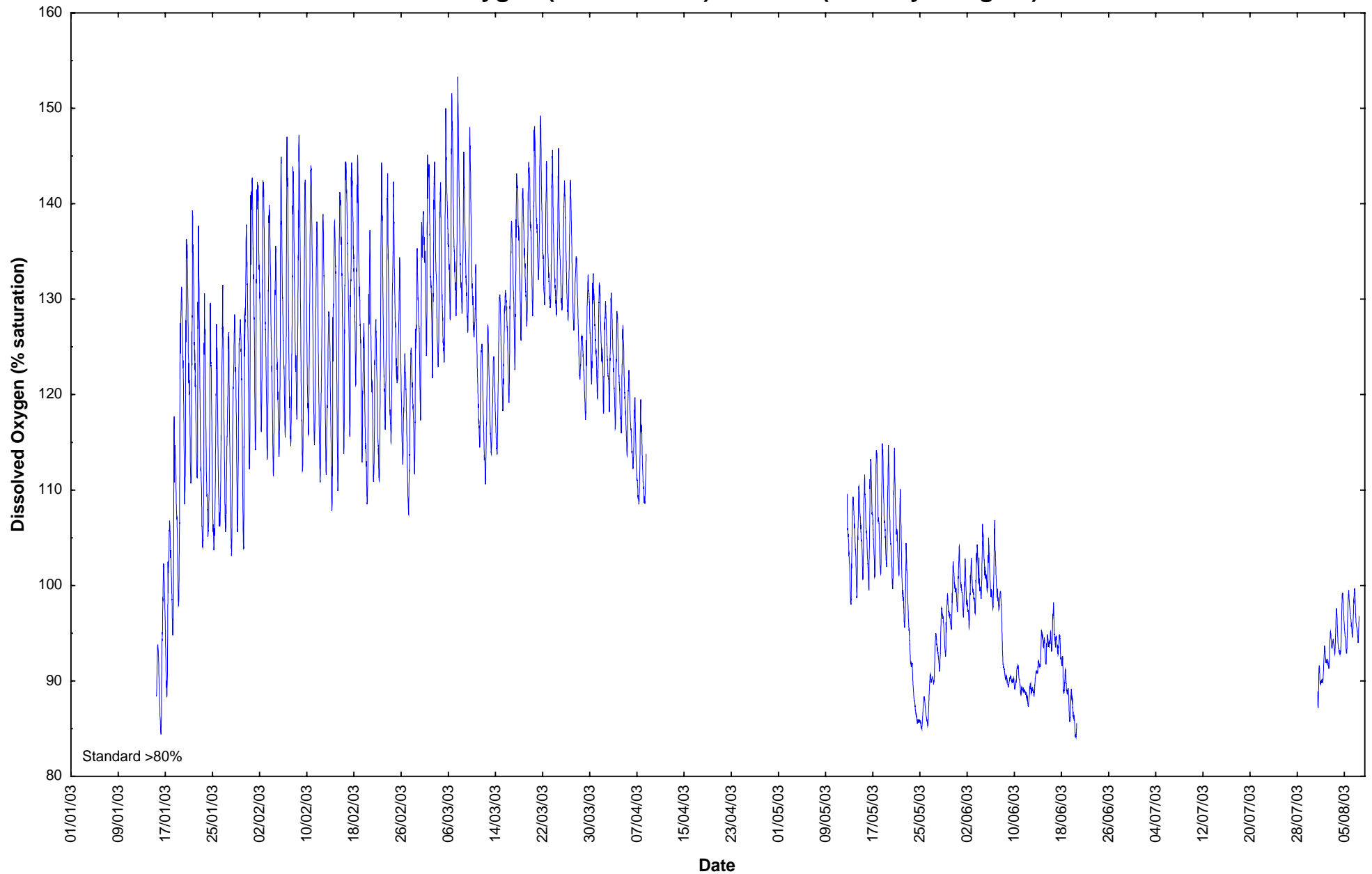
### pH: Tuakau (January - August)



### pH: Tuakau and Hamilton (October - December)

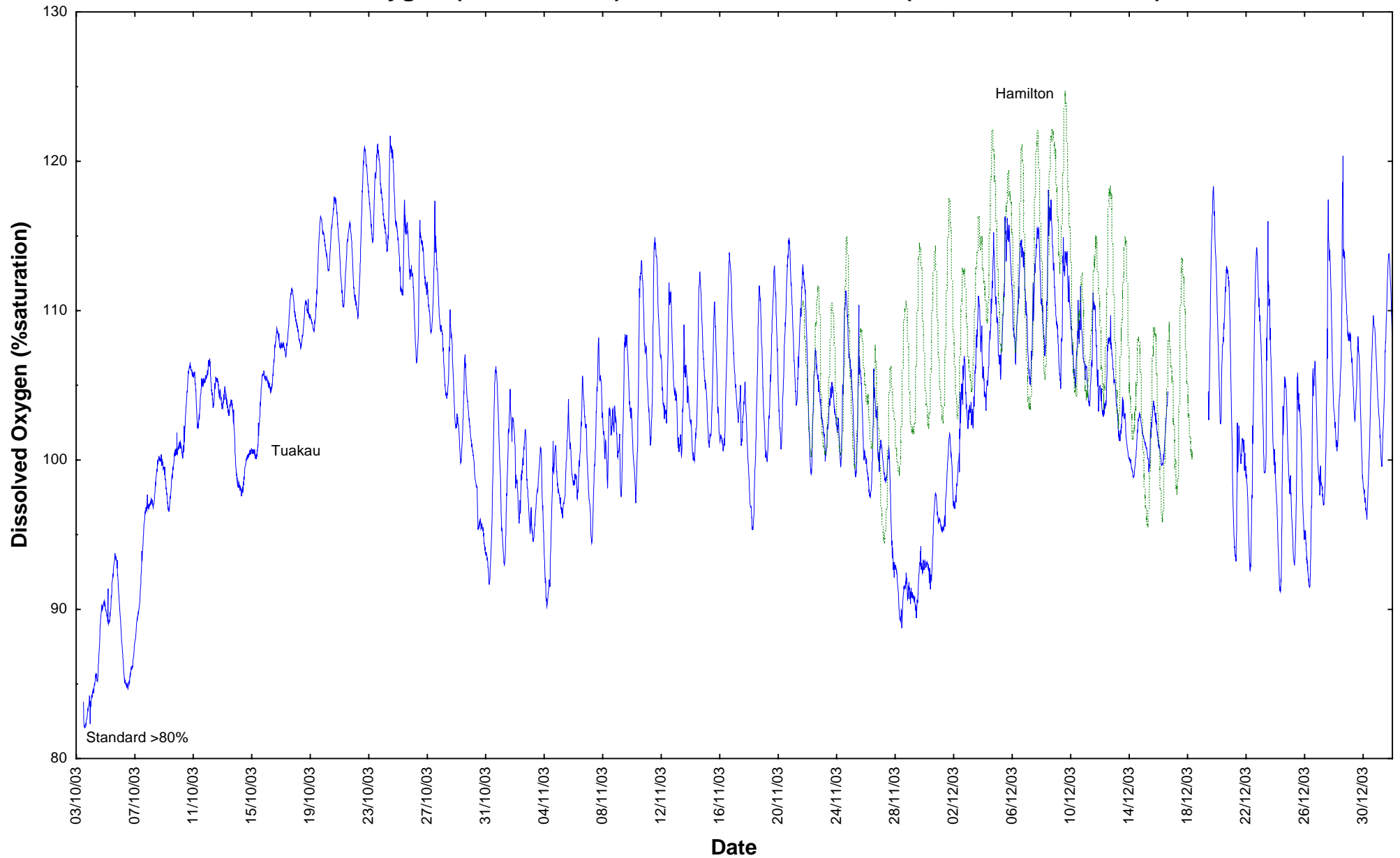


### Dissolved Oxygen (% saturation): Tuakau (January - August)

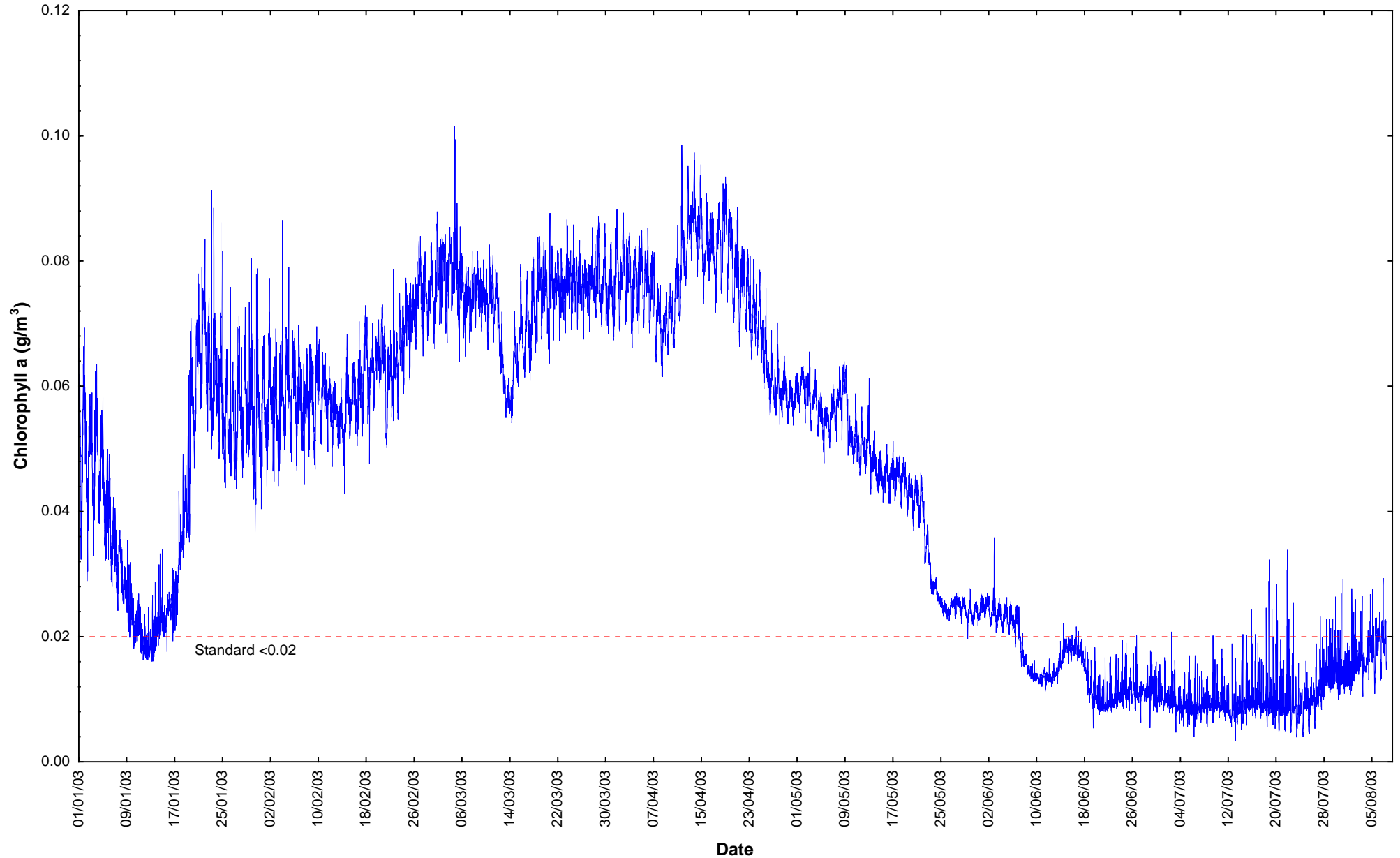




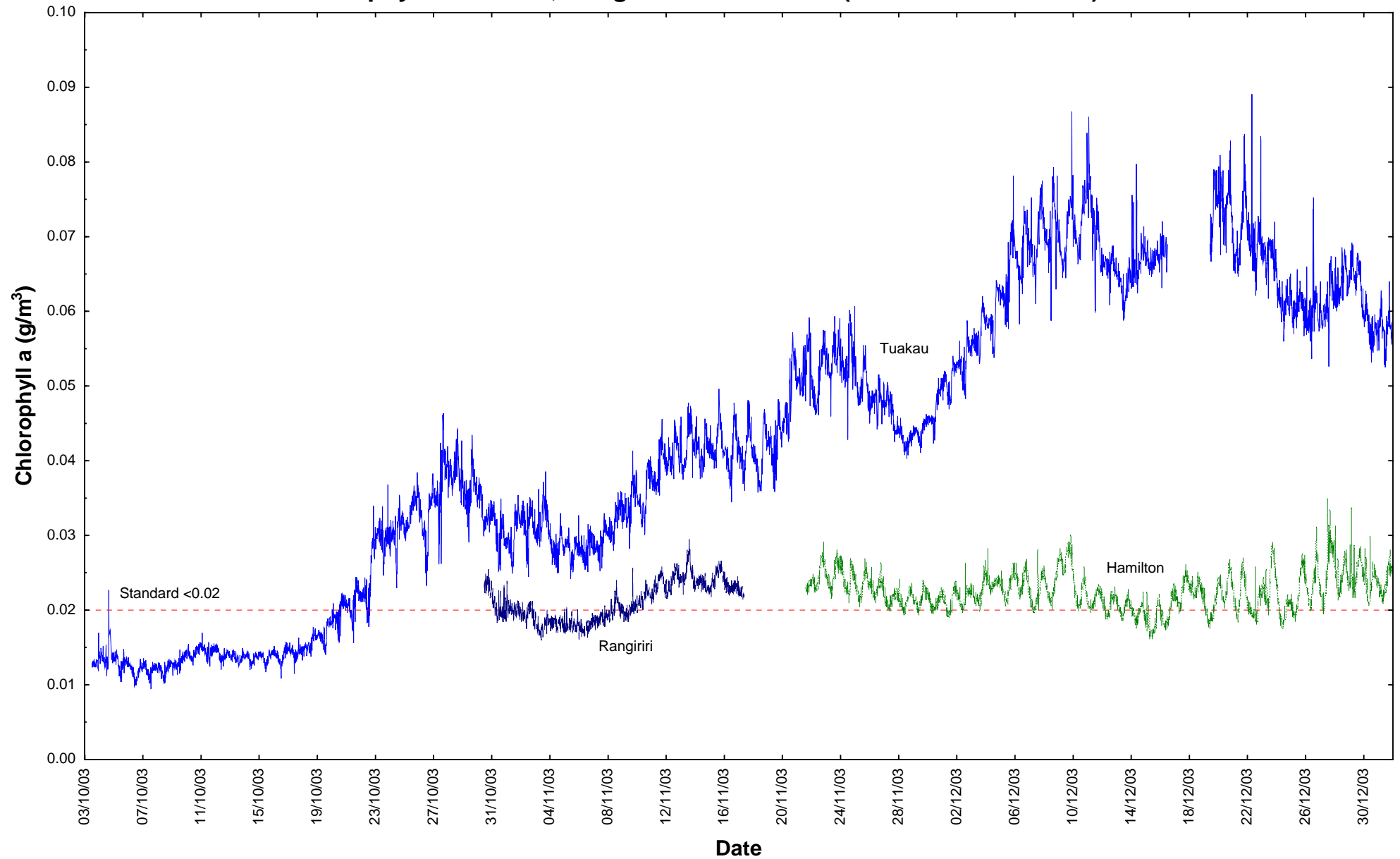
### Dissolved Oxygen (% saturation): Tuakau and Hamilton (October - December)



### Chlorophyll a: Tuakau (January - August)



### Chlorophyll a: Tuakau, Rangiriri and Hamilton (October - December)



## **Appendix III**

### **Inventory of other investigations carried out on the Waikato River since the last Report**

# Trends in River Water Quality in the Waikato Region, 1987 - 2002

Report: Technical Report 2004/02

Author: Bill Vant, Paul Smith

## **Abstract**

We analysed trends in river water quality at 110 sites in the Waikato Region using non-parametric statistical methods (seasonal Kendall slope estimator and trend test). At ten Waikato River sites we analysed records of 19 water quality variables that began in 1987 or later and ended in 2002. At the 100 other river sites records of 14 variables beginning in 1990 or later and ending in 2002 were analysed. The data were generally obtained at monthly intervals, but some records were based on quarterly sampling. Most of the records were adjusted to remove the effects of flow, and both raw and flow-adjusted records were analysed for trends.

A total of 188 Waikato River water quality records were considered. Significant trends ( $p < 5\%$ ) were found in 92 (49%) of these. Variables for which significant trends were found at five or more of the ten Waikato River sites were pH, dissolved colour, biochemical oxygen demand, arsenic, boron, ammonia and faecal coliforms. Apart from faecal coliforms, all these showed decreasing trends. The decreases in dissolved colour, biochemical oxygen demand, arsenic, boron and ammonia all represent improvements in water quality, and mostly result from improved wastewater management at known point source discharges (e.g. Kinleith mill, Wairakei power station). The decrease in pH, however, represents a deterioration. The cause of this decrease is not clear. Some of the trends in faecal coliform levels resulted from a probably harmless, non-sewage discharge to the lower river that went un-noticed until 2002, but has subsequently ceased. A more reliable measure of faecal contamination of the lower river is probably provided by the 1988-2002 records of enterococci bacteria. None of the enterococci records at the five lower river sites have shown increasing trends.

A total of 1334 water quality records from the other rivers and streams were considered. Significant trends were found in 589 (44%) of these. Across the Region as a whole, the following overall patterns were apparent: (1) significant increases have occurred in conductivity, visual clarity, total nitrogen and total phosphorus; and (2) significant decreases have occurred in dissolved oxygen, pH, turbidity, dissolved colour and ammonia. While some of these overall trends were improvements (increases in clarity and decreases in turbidity, decreases in ammonia), we consider that many of the other trends were deteriorations. The magnitudes of the trends in conductivity, visual clarity, dissolved colour, total nitrogen, ammonia, total phosphorus and dissolved reactive phosphorus were significantly correlated with the proportion of the catchment area that was in pasture (i.e. the trend slopes were correlated with land use).

For a small number of the trends at the non-Waikato River sites we can identify probable causes. However, the processes that are likely to have resulted in many of the other trends are less obvious. Some of these changes have also been observed in rivers throughout New Zealand (e.g. decreases in pH, increases in conductivity), although often at slower rates than those observed in the Waikato Region. It is therefore possible that the processes responsible are operating at a national rather than a regional scale. We consider that a concerted effort needs to be made to investigate this.

# **Appendix IV**

**Water Quality Parameters**

**Guidelines and Standards**

**Analytical Methods**

## Waikato River Water Quality Monitoring Programme Parameters

Water Quality Parameter	Reason For Monitoring	Parameter Monitored <sup>1</sup>	Comments <sup>2</sup>
<b>Dissolved Oxygen</b>	- requirement for aquatic life	DO (conc.)	routine (field)
	- indicator of organic pollution	DO (%sat.)	routine (field)
	- indicator of photosynthesis (plant growth)		
<b>Temperature</b>	- indicator of biological activity	Temperature	routine (field)
	- requirement for aquatic life		
	- mixing processes		
	- modelling studies (e.g. nutrient uptake)		
<b>Conductivity</b>	- indicator of total salts dissolved in water	Conductivity	routine
	- indicator for geothermal input	TDS	routine
<b>pH</b>	- aquatic life protection	pH	routine
	- indicator of industrial discharges, mining		
<b>Clarity</b> - turbidity - black disk (visual clarity)	- aesthetic appearance	Turbidity	routine
	- light availability for excessive plant growth	Black disk	routine (field)
	- aquatic life protection		
	- indicator of catchment condition, land use		
<b>Colour</b> - light absorption	- aesthetic appearance	Munsell colour	routine (field)
	- light availability for excessive plant growth	Absorbance at:	routine
	- indicator of presence of organic matter	340,440,780nm	
<b>Nutrients (N and P) Chlorophyll a</b>	- enrichment, excessive plant growth	NO <sub>3</sub> -N+NO <sub>2</sub> -N	routine
	- nutrient limitation for plant/algal growth	NH <sub>4</sub> -N,TKN	
		DRP, TP, Chl a	
<b>Geothermal Contaminants</b>	- indicators of geothermal inflows	Cl, Li, B, As	routine
	- aquatic life protection (ecotoxicity)		
	- drinking water (human health aspects)		
<b>Organic Carbon</b>	- indicator of organic pollution	BOD <sub>5</sub>	routine
	- catchment characteristics	TOC/DOC	routine
<b>Faecal Bacteria</b> - E. coli - enterococci - faecal coliforms	- indicator of pollution with faecal matter	E. Coli	routine
	- disease risk for swimming etc.	ENT	routine
		FC	routine

<sup>1</sup> see the page 54 for the meaning of the abbreviations.

<sup>2</sup> routine means sampled monthly.

## Details of Water Quality Standards and Guidelines for “Satisfactory” Water Quality

Parameter	Critical Value(s)	Source
Dissolved oxygen	>80% of saturation concentration	RMA Third Schedule, Classes AE, F, and FS.
pH	6.5–9	ANZECC (1992) and Canadian guidelines for freshwater aquatic life (1987).
Turbidity	<5 NTU	Studies of adverse effects on underwater light—and thus on plant and invertebrate production—in certain South Island streams (Davies-Colley 1991).
Ammoniacal-nitrogen	<0.88 g/m <sup>3</sup>	USEPA (1998) value for 1-hour exposure at pH 9.
Temperature	<12°C (May – Sep) <20°C (Oct – Apr)	Environment Waikato Proposed Regional Plan standards for trout fisheries and trout spawning (1998).
Total phosphorus	<0.04 g/m <sup>3</sup>	From upper quartile values for 77 New Zealand rivers in NIWA’s National Water Quality Network (after Smith & Maasdam 1994)—note that the guidelines for “excellent” conditions are the lower quartile concentrations for these rivers.
Total nitrogen	<0.5 g/m <sup>3</sup>	From upper quartile values for 77 New Zealand rivers in NIWA’s National Water Quality Network (after Smith & Maasdam 1994)—note that the guidelines for “excellent” conditions are the lower quartile concentrations for these rivers.
Water clarity at baseflow	>1.6 m	“Baseflow” defined as flows less than the upper decile flow. Guideline from Ministry for the Environment (1994).
Escherichia coli	<550/100 mL	Ministry for the Environment (2003) guidelines for the management of recreational and marine shellfish-gathering waters.
Median Escherichia coli	<126/100 mL	Ministry for the Environment (1999) guidelines for the management of recreational and marine shellfish-gathering waters.
Enterococci	<77/100 mL	Department of Health (1992) guidelines for “moderate” level of recreational use.
Median Enterococci	<33/100 mL	Department of Health (1992).
Chlorophyll a	<0.02 g/m <sup>3</sup>	Ministry for the Environment (1992).
Arsenic	<0.01 g/m <sup>3</sup>	Ministry of Health (2001).
Boron	<1.4 g/m <sup>3</sup>	Ministry of Health (2001).



## Waikato River Monitoring Programme - Water Quality Parameters & Analytical Methods

Id <sup>1</sup>	Parameter	Method
A340F	Absorbance @ 340 nm Filtered	Spectrophotometer, 1 cm path length, APHA method 5910B
A440F	Absorbance @ 440 nm Filtered	Spectrophotometer, 1 cm path length, APHA method 5910B
A780F <sup>†</sup>	Absorbance @ 780 nm Filtered	Spectrophotometer, 1 cm path length, APHA method 5910B
As	Arsenic Total	Nitric acid digestion, ICP-MS, APHA method 3125B
B	Boron	ICP-MS, APHA method 3125B
BDISK	Black Disk	Field measurement, horizontal water transparency (20mm, 60mm, 100mm, 200mm disk) in river or trough (20mm only)
BOD <sub>5</sub>	Biochemical Oxygen Demand (5 day)	Incubation 5 days at 20°C, DO-meter, No nitrification inhibitor added, unseeded, APHA method 5210B
CHLA	Chlorophyll a	Acetone extraction. Spectroscopy. APHA method 10200H
Cl	Chloride	Filtered sample. Ion Chromatography APHA method 4110B
COLOUR	Colour	Field measurement, Munsell Colour Patches
COND	Conductivity	Lab Meter @ 25°C. APHA method 2510B
DO	Dissolved Oxygen	Field measurement (WTW DO meter, model 340A)
DO (% Sat)	Dissolved Oxygen (percent saturation)	Field measurement (WTW DO meter, model 340A)
DOC	Dissolved Organic Carbon	Filtration, acidification, purging to remove inorganic C, catalytic oxidation, IR detection. APHA method 5310B (modified)
DRP	Dissolved Reactive Phosphorus	Molybdenum Blue Colorimetry. Flow injection analyser. APHA 4500 PG (proposed)
E. coli	Escherichia coli	Membrane Filtration (mFC Agar) confirmation by NA-MUG Agar. APHA method 9222G
ENT	Enterococci bacteria	Membrane Filtration (mE Agar) confirmation by EIA Agar. APHA method 9230C
FC	Faecal Coliforms	Membrane Filtration (mFC Agar). APHA method 9222
Flow	Flow – Instantaneous	Calculated from rating curve ± 8%
Li	Lithium	ICP-MS, method APHA 3125B
NH <sub>4</sub> -N	Ammoniacal Nitrogen (Total)	Phenol/Hypochlorite Colorimetry. Flow injection analyser. APHA method 4500-NH <sub>3</sub> G
NNN	Nitrite/Nitrate Nitrogen	Automated Cadmium reduction. Flow injection analyser. APHA method 4500 – NO <sub>3</sub> I (proposed).
NO <sub>3</sub> -N	Nitrate Nitrogen	Calculation: (Nitrate-N + Nitrite -N) – Nitrite - N
PH	pH	Lab Meter @ 25°C. APHA method 4500-H <sup>+</sup> B
TDS	Total Dissolved Solids	Filtration, gravimetric. APHA 2540C (modified)
TEMP	Temperature	Field measurement (WTW DO meter, model 340A)
TKN	Total Kjeldahl-Nitrogen	Acid digestion. Phenol/Hypochlorite Colorimetry. APHA method 4500-N <sub>org</sub> D (modified)
TOC	Total Organic Carbon	Acidification, purging to remove inorganic C, catalytic oxidation, IR detection. APHA method 5310B (modified)
TN	Total Nitrogen	Calculated from NNN + TKN (Nitrite/Nitrate Nitrogen + Total Kjeldahl-Nitrogen)
TP	Total Phosphorus	Persulphate digestion, Colorimetry. APHA method 4500-PB,E (modified)
TURB	Turbidity	Turbidity Meter Hach 2100N. APHA method 2130B

<sup>1</sup> Water quality parameter identification code refers to Environment Waikato's water quality database (HYDROL) parameter short name.

APHA = Standards Methods for the Examination of Water and Wastewater, 20<sup>th</sup> Edition, 1998, APHA, AWWA, WEF

ICP-MS = Inductively Coupled Plasma – Mass Spectroscopy